

Bulletin of the
University of
New Hampshire
1969-70



Graduate
Catalog Issue

The Graduate School 1969-70

Volume LX, Number 14, April 1969

The Bulletin of the University of New Hampshire is published twice in August, November, December, January, February, and April, and once in July, September, and October. Second-class postage paid at Durham, New Hampshire 03824.

Contents

Campus Map	4
University Calendar	5

Officers and Committees of the Graduate School

Trustees	7	Committees	10
Administrative Officers	8		

Graduate Education at the University of New Hampshire

Background	11	Teaching, Service, and Research	13
Location and Facilities	12	Cultural Activities	14
Student Activities	12	University Services	15

Regulations of the Graduate School

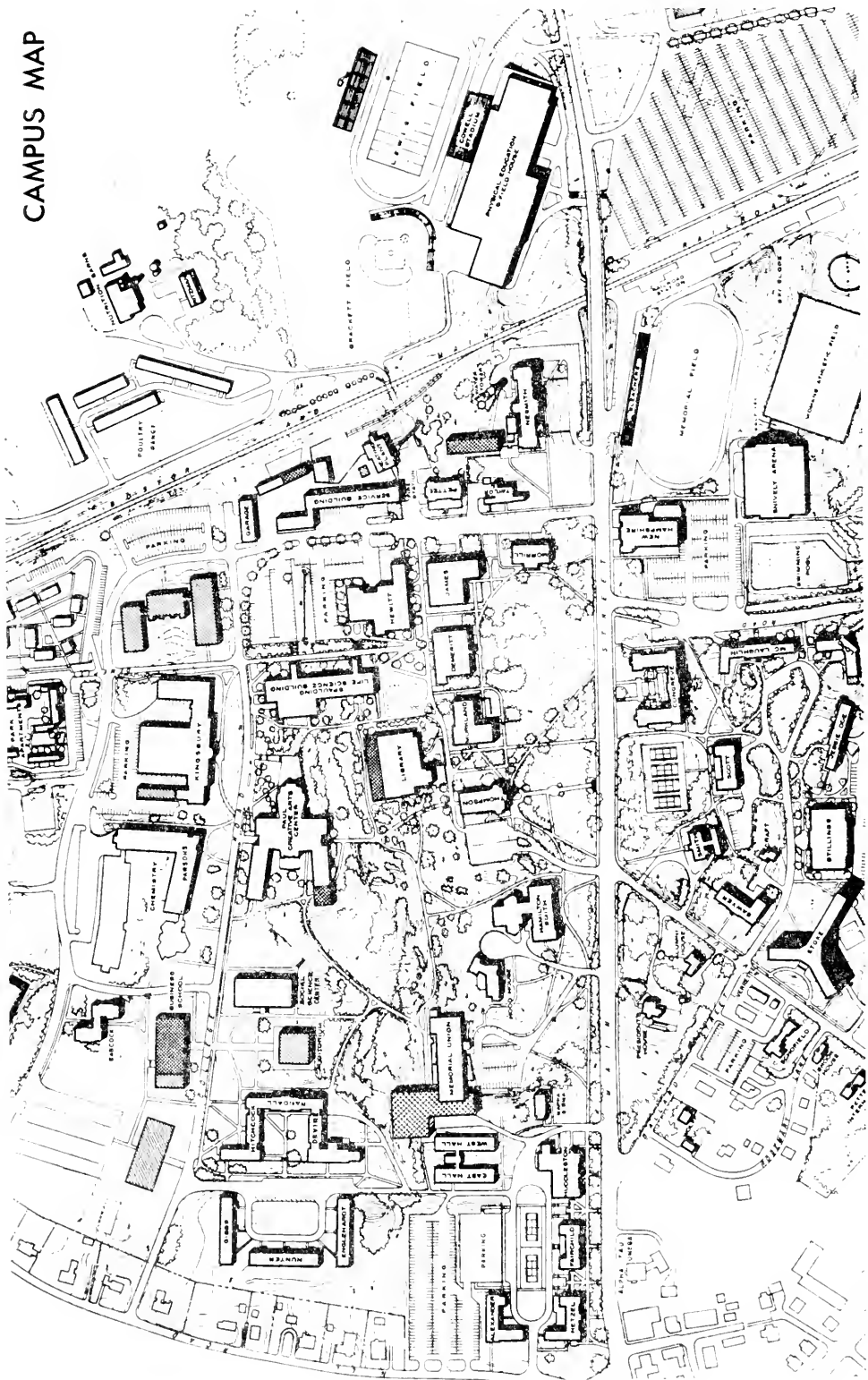
General Regulations	19	Requirements for Doctor's Degree	26
Assistantships, Scholarships, and Fellowships	22	Course Numbering System	27
Graduate Degree Programs	24	IBM Key Codes	28
Requirements for Master's Degree	25		

Departmental Requirements and Course Descriptions

Agricultural Education	29	History	91
Animal Sciences	31	Home Economics	97
Biochemistry	33	Interdisciplinary Options and Programs	99
Biology	35	Mathematics	100
Botany	36	Mechanical Engineering	106
Business Administration	39	Microbiology	111
Chemical Engineering	44	Music	113
Chemistry	46	Physics	119
Civil Engineering	52	Plant Science	122
Economics	56	Political Science	124
Education	59	Psychology	129
Electrical Engineering	66	Resource Economics	134
English	70	Sociology	136
Entomology	75	Soil and Water Science	142
Forest Resources	76	Spanish and Classics	144
French and Italian	79	Technology	146
Genetics Program	81	Zoology	146
Geology	85		
German and Russian	87		

Faculty of the Graduate School

CAMPUS MAP



University Calendar 1969-1970

Semester I

September 14, Sunday	8 A.M. Residence halls open
September 15, Monday	Registration
September 15, Monday	4 P.M. First Faculty meeting
September 16, Tuesday	8 A.M. Opening convocation
September 16, Tuesday	10 A.M. Classes follow abbreviated schedule
September 26, Friday	4:30 P.M. Last day to add courses
October 8, Wednesday	First graduate faculty meeting
October 15, Wednesday	Last day for refund on withdrawal
November 10, Monday	4:30 P.M. Last day to drop courses
November 25, Tuesday	7 P.M. Residence halls close, Thanksgiving
November 30, Sunday	2 P.M. Residence halls open
December 1, Monday	8 A.M. Classes resume
December 12, Friday	7 P.M. Residence halls close, Christmas
January 4, Sunday	2 P.M. Residence halls open
January 5-16, Monday-Friday	Reading period
January 19, Monday	Last day for presenting Ph.D. dissertations at Graduate School Office, if degree candidate in February.
January 19, Monday	8 A.M. Semester I final examinations begin
January 27, Tuesday	9 A.M. Senior grades due
January 29, Thursday	6 P.M. Final examinations end
January 29, Thursday	8 P.M. Residence halls close
February 1, Sunday	Commencement

Semester II

February 8, Sunday	2 P.M. Residence halls open
February 9, Monday	Registration
February 10, Tuesday	8 A.M. Classes resume
February 14, Saturday	Classes held, Monday schedule
February 20, Friday	4:30 P.M. Last day to add courses
March 11, Wednesday	Last day for refund on withdrawal
March 27, Friday	7 P.M. Residence halls close, Easter
April 5, Sunday	2 P.M. Residence halls open
April 6, Monday	8 A.M. Classes resume
April 13, Monday	4:30 P.M. Last day to drop courses
April 13, Monday	Last day for filing application for 1969 Summer Session graduate scholarships
May 11-22, Monday-Friday	Reading period
May 15, Friday	Last day for presenting Ph.D. dissertations at Graduate School Office, if degree candidate in June
May 22, Friday	Last day for final Ph.D. oral exam, if degree is to be granted in June
May 25, Monday	8 A.M. Semester II final examinations begin
May 30 Saturday	Memorial Day — holiday
June 2, Tuesday	9 A.M. Senior grades due
June 5, Friday	6 P.M. Final examinations end
June 7, Sunday	Commencement
	3 P.M. Residence halls close

Officers and Committees of the Graduate School

Trustees

His Excellency Walter R. Peterson, A.B.
Governor of New Hampshire, ex officio

Frank T. Buckley
Commissioner of Agriculture, ex officio

Newell J. Paire, B.Ed., M.Ed.
Commissioner of Education, ex officio

John W. McConnell, B.A., Ph.D., D.Sc.
President of the University, ex officio

Harold E. Hyde, B.S., M.S., Ed.D.
President of Plymouth State College, ex officio

Leo F. Redfern, B.A., M.A., M.P.A., Ph.D.
President of Keene State College, ex officio

Fred W. Hall, Jr., B.S., LL.B.
Rochester (1966-1969), Chairman of the Board

Richard W. Daland, B.S.
Durham (1966-1970), Vice Chairman of the Board

Norman S. Weeks, B.S.
Laconia (1965-1969), Secretary of the Board

Maurice F. Devine, A.B., LL.B., LL.D.
Manchester (1949-1970)

J. Fred French
Manchester (1961-1972)

Sinclair Weeks, A.B., LL.D.
Lancaster (1961-1969)

Offices and Committees of the Graduate School

Albert R. Furlong, B.E., M.E.

Keene (1963-1971)

Norman C. Berube, B.A., M.D.

Manchester (1963-1971)

George R. Hanna, B.A., LL.B.

Keene (1963-1971)

Mildred McAfee Horton, B.A., M.A., LL.D.

Randolph (1963-1971)

Bernard I. Snierston, A.B., LL.B.

Laconia (1963-1971)

Ray Howland, Jr.

Stratham (1966-1970)

George T. Gilman, B.S.

Farmington (1967-1971)

Mildred K. Perkins, B.E.

Concord (1967-1971)

Charles V. Spanos, B.A., LL.B.

Claremont (1967-1971)

Lewis J. Fisher, LL.B.

Dover (1968-1971)

Frederick C. Walker, B.S., Ed.M.

Dover (1968-1972)

Richard H. Keefe, A.B., LL.D.

Dover (1968-1972)

Administrative Officers

John W. McConnell, Ph.D.

President of the University and Professor of Economics

Jere A. Chase, M.Ed.

Executive Vice President

Norman W. Myers, B.S.

Vice President-Treasurer

Robert F. Barlow, Ph.D.

Academic Vice President and Professor of Economics

Robert N. Faiman, M.S., Ph.D.

Vice President for Research and Professor of Electrical Engineering

Harry A. Keener, M.S., Ph.D.

Dean of the College of Agriculture

Eugene S. Mills, M.A., Ph.D.

Dean of the College of Liberal Arts and Professor of Psychology

Jan Clec, Ph.D.

Dean of the Whittemore School and Associate Professor of Organizational Development

H. Trevor Colbourn, Ph.D.

Dean of the Graduate School and Professor of History

Richard S. Davis, M.S., Ph.D.

Dean of the College of Technology

John B. Hraba, Ph.D.

Dean of Institutional Research and Planning and Professor of Electrical Engineering

William H. Drew, M.S., Ph.D.

Associate Dean of the Graduate School, Coordinator for Research, and Professor of Resource Economics

Edward J. Durnall, Ed.M., Ed.D.

Director of University Extension, Director of the Summer Session, and Associate Professor of Education

Leslie C. Turner, M.Ed.

Registrar

Donald E. Vincent, A.M.L.S., A.M.

Librarian

Officers and Committees of the Graduate School

Committees

Graduate Council

- John W. McConnell, Ph.D.**
President of the University
- H. Trevor Colbourn, Ph.D.**
*Dean of the Graduate School,
Chairman*
- William H. Drew, Ph.D.**
*Associate Dean of the Graduate
School*
- Alexander R. Amell, Ph.D.**
Professor of Chemistry
- Thomas A. Carnicelli, Ph.D.**
Assistant Professor of English
- Robert W. Corell, Ph.D.**
*Professor of Mechanical
Engineering*
- Roland B. Kimball, Ed.D.**
Professor of Education
- Arnold S. Linsky, Ph.D.**
Assistant Professor of Sociology
- M. Evans Munroe, Ph.D.**
Professor of Mathematics
- Sam Rosen, Ph.D.**
Professor of Economics
- Douglas G. Routley**
*Associate Professor of
Biochemistry and Plant Science*
- Samuel C. Smith, Ph.D.**
*Associate Professor of Biochemistry
and Poultry Science*
- Robert I. Watson, Ph.D.**
Professor of Psychology
- Paul A. Wright, Ph.D.**
Professor of Zoology

Tuition Scholarships

- Gerald L. Klippenstein, Ph.D.**
*Assistant Professor of Biochemistry,
Chairman*
- Manley R. Irwin, Ph.D.**
Associate Professor of Economics
- Douglas M. Norris, Ph.D.**
Associate Professor of Mechanics
- M. Daniel Smith, Ed.D.**
Associate Professor of Education

Research Council

- William H. Drew, Ph.D.**
*Associate Dean of the Graduate
School, Chairman*
- Fletcher A. Blanchard, M.S.**
Professor of Electrical Engineering
- Walter M. Collins, Ph.D.**
Professor of Poultry Science
- Robert N. Faiman, Ph.D.**
Vice President for Research
- Robert D. Hapgood, Ph.D.**
Associate Professor of English
- John W. Hatch, M.F.A.**
Professor of The Arts
- Harry A. Keener, Ph.D.**
Dean of the College of Agriculture
- Theodore G. Metcalf, Ph.D.**
Professor of Microbiology
- Stuart H. Palmer, Ph.D.**
Professor of Sociology
- J. John Uebel, Ph.D.**
Associate Professor of Chemistry

Graduate Education at the University of New Hampshire

Background

The University of New Hampshire began its life as the "New Hampshire College of Agriculture and the Mechanic Arts" in 1866. Originally located in Hanover, the New Hampshire College moved to Durham in 1893. Here it developed more rapidly, aided by the substantial bequest of Benjamin Thompson. In 1923 the State granted its land-grant College a new charter as the University of New Hampshire. Five years later the Graduate School was formally added to the University system. The University presently contains the following colleges and schools: College of Agriculture, College of the Liberal Arts, College of Technology, Whittemore School of Business and Economics, Thompson School of Applied Science, and the Graduate School. The University also includes as component parts the State Colleges located at Keene and Plymouth. The major thrust of graduate education is at the University campus in Durham.

Although the first Ph.D. was awarded in 1896, graduate education at the University had its formal beginnings forty years ago. The development of the graduate programs has been gradual and systematic with the quest being for academic excellence and for programming commensurate with institutional resources and regional opportunities. The Graduate School offers an environment where the search for knowledge and understanding can be stimulated and sustained. The graduate student is expected to make use of such opportunities and to demonstrate the maturity and self-discipline on which true scholarship is based.

The Graduate School is administered by the Dean of the Graduate School in association with the Associate Dean and Coordinator for Research; the Graduate Council serves in an advisory capacity. Graduate studies at the University are supervised by the Graduate Faculty.

Graduate Education

Location and Facilities

Few institutions of higher learning are as ideally located as the University of New Hampshire. Durham is one of the oldest towns in northern New England, and traces of its colonial past are everywhere apparent. To the south, ninety minutes away, are metropolitan Boston and all the cultural opportunities a great urban area can offer. To the north, an equal distance in time, are the White Mountains and unsurpassed skiing, hiking, and scenery. Twenty minutes to the east are the beaches and rocky coasts of New Hampshire and Maine.

The University campus in Durham is 156 acres in size. There are 35 buildings devoted to administration, instruction, and research, and 19 residence halls for men and women. Total University lands — including athletic fields, farms, and woodlands — comprise 2,830 acres, valued at more than \$31,000,000.

Major construction projects of the past ten years include:

University Library, housing 500,000 volumes, 4,000 periodicals, and substantial microfilm and tape collections.

Paul Arts Center, a \$2,250,000 structure with separate wings for music, drama, and the arts.

Social Science Center, completed in 1968, has the Graduate School Offices and facilities for several departments in the Social Sciences.

Spaulding Life Science Building, with facilities for the departments of Biochemistry, Microbiology, and Zoology.

Physical Education Facilities, including an indoor track and pool and Snively Arena, an indoor hockey rink, have recently been completed at a cost of \$3,600,000.

Whittemore School Building, scheduled for completion in September 1969, will house the business and economics departments with extensive facilities including computer equipment.

Parsons Hall, the first phase of which was completed in 1966, provided completely new facilities for the Department of Chemistry. The second phase of construction will be completed by the fall of 1970.

Other new buildings since 1946 include the University's engineering building, student recreation center, nutrition laboratory, twelve residence halls, a dining hall, and housing for married students and faculty.

Student Activities

Graduate Student participation in University activities is substantial. The newly formed Graduate Student Senate considers questions relating to social, administrative, and academic affairs; and an office has been provided in the Graduate School for Senate use. Graduate Students are often consulted by departments about academic decisions. Three graduate students are elected to and serve on the Graduate Council. The University's primary governing body in matters of student conduct and academic policy is the University Senate comprised of 30 faculty members, 12 members of the administration, 5 graduate students, and 30 undergraduates — all with equal voting rights. This reflects the current effort at the University to increase student participation in the governing process.

In the new Graduate School office a large lounge and kitchen are available to students and departments for academic and social events.

Teaching, Service, and Research

The Afro-American Society participates actively in University affairs.

Information and counseling are available concerning a student's military obligation.

Durham has Episcopal and Roman Catholic churches, a Community Church, and a Unitarian-Universalist Fellowship. A synagogue, Friends meeting, and churches of other faiths are located in Dover.

A number of student organizations help promote religious life on the campus. There are clubs for Episcopal, Christian Science, Mormon, Jewish, Catholic, and Greek Orthodox students; a Christian Association with a full-time chaplain for Protestant students; and an Inter-Varsity Fellowship.

Many of the over forty student organizations welcome graduate-student participation.

Teaching, Service, and Research

The University of New Hampshire has a faculty of 580, including those who teach part-time. Their main function is teaching, but many — perhaps a majority — are also deeply involved in research and service activities.

Among the University's specialized research facilities are the *Space Science Center* in DeMeritt Hall, the *Ritzman Animal Nutrition Laboratory*, and the *Computation Center* in Kingsbury Hall.

One of the largest research and service units is the *Agricultural Experiment Station*, which conducts research, publishes results, and provides testing services for New Hampshire farmers. A similar service for New Hampshire industry is provided by the *Engineering Experiment Station*.

The *Cooperative Extension Service*, operating in conjunction with the U. S. Department of Agriculture, bridges the gap between campus research and the people of the state.

Formal adult education is conducted by the *University Extension Service*, which offers credit and non-credit courses anywhere in the state where there is sufficient demand.

The University operates New Hampshire's educational television station, *WENH-TV*, broadcasting in-school programs for 80,000 young people, and, during the evening hours, cultural and educational programs.

Another major extension service of the University is the *New England Center for Continuing Education*. This facility will house research and service activities for the entire six-state region.

Other University units which place its resources at the service of the state: the *Resources Development Center*, which brings the talents and techniques of the social scientist into closer partnership with state and local governments; the *Public Administration Service*, which specifically aids town and city officials; the *Water Resources Research Center*; and the *Bureau of Educational Research and Testing*.

The New Hampshire State Entomologist and State Geologist are University faculty members with offices on campus.

The *Engineering Design and Analysis Laboratory* is an interdisciplinary faculty group predominantly from the College of Technology. EDAL-associated faculty and graduate students participate mainly in marine-oriented engineering projects.

Graduate Education

The *Jackson Estuarine Laboratory*, the University's newest research facility, is an 8,400 square foot structure located about five miles from the University campus on the shore of the Great Bay at Adam's Point. The tidewater area in the Great Bay estuarine complex covers more than 15,000 acres. Tidal water enters and leaves via the Piscataqua River; some 13.5 billion gallons ebb and flow on an average tide of eight vertical feet. The continental shelf of the Gulf of Maine is within about thirteen miles steaming distance of the Laboratory. Marine research facilities for the departments of biochemistry, botany, microbiology, zoology, and geology will be contained in the Laboratory. Also included are a circulating seawater system, a shop for maintenance of oceanographic gear, a small library-conference area, and a pier for docking research vessels.

The principal research topics of the Jackson Estuarine Laboratory are a study of the estuarine and continental shelf food-web, biotoxins from marine organisms, and pollution in the marine environment.

This project has received support from the National Science Foundation and the New England Regional Commission.

Further information about the above service activities may be obtained by writing the director of the appropriate unit, or from: the Director, Division of Industrial and Community Services, Schofield, Durham, N. H. 03824.

Cultural Activities

A substantial range of cultural activities complements the regular academic program.

An outstanding program in music each year includes concerts and operas by student groups and recitals by faculty members. The University also sponsors a "Blue and White" concert series which brings professional musicians to the campus. In recent years, this series has included Eileen Farrell, the Czech Philharmonic, and the Metropolitan Opera Studio.

Drama is offered several times during the year by the University Theater. There are professional productions in the "Allied Arts" series, which has included performances by Emlyn Williams, Richard Dyer-Bennet, and the Eric Hawkins dance company.

There are many public lectures at the University, by faculty and off-campus speakers. One lecture series brings outstanding men and women of arts, letters, science, and the humanities to the campus for a formal lecture and informal meetings with students. Another series concentrates on issues, and brings one or more noteworthy men to Durham to speak on an important topic such as civil rights. Recent visitors in these series have included Crane Brinton, Aaron Copeland, Robert Penn Warren, Arthur Kornberg, Margaret Meade, and a Black Power Symposium with James Strickland and Harold Hatcher.

In the galleries of Paul Creative Arts Center, there is a continually changing program of exhibits to interest both the art student and the layman.

Student groups are also active in promoting cultural and educational events. New-est of these student ventures is a film series. There is also a student FM radio station. Political clubs often bring speakers of national prominence to the campus.

University Services

The Counseling and Testing Center

The Counseling and Testing Center provides, without charge and through a professionally qualified staff, a range of psychological services to students who are experiencing a persistent personal or emotional difficulty, or some disruption in their academic lives. The services of the office are not limited to those with severe problems, but are geared to the needs of the typical college student. Diagnostic services, with the assistance of a consulting psychiatrist, are also available to students whose needs go beyond the scope of our own facilities. In such cases, treatment planning and/or referral to outside sources are provided.

The University Health Service

The University Health Service, located in Hood House, is devoted to the protection, improvement, and maintenance of student health. Graduate students carrying eight or more credits and graduate assistants are eligible for treatment. A well-equipped outpatient clinic functions for diagnosis and treatment of ambulatory patients; and a modern infirmary of twenty-six beds, with an isolation division for communicable diseases, is available for students who require inpatient care. During the regular academic year registered nurses are on duty at all times. Individual health guidance is given through personal conferences with the University physicians. Routine office hours of the University physicians are from 9:00 a.m. to 12:00 noon and 1:30 p.m. to 4:00 p.m. daily, except Saturdays and Sundays when emergency care is available. Bed patients at Hood House are charged \$5.00 per day.

The Health Service is closed when the University is officially closed for holidays, closing one hour after the dormitories, and opening at 3:00 p.m. on the day before classes resume. During the Summer Session, Hood House is open 24 hours a day with a limited staff on duty. A doctor is on call and nurses will decide when a doctor's attention is needed after hours.

Injury and illness which require hospital confinement, services of specialists, operations, special nurse, or special prescriptions are at the expense of the student.

In addition to the health service available through Hood House, group accident and sickness insurance, giving twelve-months coverage, is available to students at the University. This insurance coverage is designed to supplement the program of the University. Complete details may be had on application to the Business Office.

The Memorial Union

The Memorial Union is a campus center for outside-the-classroom activities for the University community. It provides social, recreational, and educational meeting rooms; game rooms; and meals and snacks; it serves as headquarters for a number of student organizations. The Union staff reserves rooms for organizations to meet in the Memorial Union and in other University buildings and serves as a central source of campus information. A program of activities for all students is planned by the all-student board of governors of the Memorial Union Student Organization.

The Memorial Union is the gift of the citizens of New Hampshire, the students, the alumni, the faculty and staff, and other friends of the University. The building serves three principal purposes: a living memorial to the men and women of the state of New Hampshire who have sacrificed their lives in our armed forces, a college union, and a state-wide conference center.

Graduate Education

The University Placement Service

The objective of University Placement is to assist students in obtaining permanent employment upon graduation from the University. The office maintains contact with recruiting personnel from business, industry, government, and education, and keeps up-to-date data on positions available as well as vocational information about employing organizations. The Service provides vocational counseling as an adjunct to the faculty-student relationship. An on-campus interview program is administered by the Service which brings recruiting personnel to the campus each year between November and April.

The services of University Placement are also available to undergraduate and graduate students seeking summer employment during their years at the University.

University Placement also assists UNH alumni in their post-collegiate placement activities.

It is the policy of University Placement to provide students with information about employing organizations and to discuss particular employment opportunities with interested registrants. The final decision concerning a registrant's acceptance or rejection of an offer of employment, however, always rests with the registrant.

Registration is important and should be completed by the student while on campus, even though permanent employment is not sought immediately after graduation.

Housing and Dining Services

Babcock House, completed in January 1968, is the graduate residence for single graduate students. Two, six-story towers, connected at each floor by a common lounge, accommodate 180 men and women. Facilities include a large lounge with fireplace, two recreation rooms, food-vending room, coin-operated laundry, TV room, ski storage, luggage storage, and individual mail lock boxes. The Faculty-Member-in-Residence and his family live in a two-bedroom apartment on the ground floor.

The residence rooms are all single rooms allowing complete privacy for consultation with students or faculty. Rooms are furnished with a bed, mattress, pillow, easy chair, desk chair, waste basket, and a built-in desk-dresser-wardrobe unit with book shelves, mirror, medicine chest, and desk lamp. Residents provide their own bedding. An optional linen service is available furnishing bed linen, towels, and blankets. Linen and towels are laundered weekly. The charge for this service will be \$25.00 for linen and towels or \$31.00 for linen, towels, and two blankets. Room rent is \$500.00 for the academic year.

Babcock house is located on College Road opposite Randall and Hitchcock residence halls. Parking space is available for graduate students. Although there will be no meal preparation in Babcock House, residents may elect to take a 21-meal contract at either *Huddleston* or *Stillings dining halls*, if space is available, for \$500.00 for the academic year. A 15-meal (Monday breakfast through Friday supper) contract may be purchased for \$440.00 for the academic year. Students who do not wish to take the contract may buy individual meals on a cash basis. The *University Dining Services* also operate a cafeteria in the Memorial Union where meals may be obtained normally on an *a la carte* plan. However, during the year 1969-70, remodeling is planned at the Union and this service may have to be interrupted.

As soon as a student is notified of his admission to the Graduate School, he may request a housing application and contract. Please read carefully the housing contract because it is binding for the entire academic year beginning in September and ending in June.

Off-Campus Housing — The University Residence Office maintains a partial listing of off-campus apartments, rooms, and houses within the immediate area of Durham. Because of the day-to-day changes in this list it is not feasible to send copies. A trip to Durham will usually prove more satisfactory. The Residence Office is open Monday through Friday, 8:00–12:00 and 1:00–4:30.

On-campus housing for married graduate students is available in Forest Park, a complex of studio, one- and two-bedroom apartments. Telephone and electrical services are paid by the tenant and a lease is required.

Because of heavy demand for these facilities, the Residence Office encourages graduate students interested in Forest Park to apply a semester prior to intended occupancy. Studio apartments rent for \$82.50 per month; one-bedroom apartments, \$97.50; two-bedroom apartments, \$110 and \$125.

Apartments are assigned according to family size. A couple with no children qualifies for a studio apartment. A one-child family will be placed in a one-bedroom apartment. With two or more children a two-bedroom apartment is assigned.

To obtain housing application forms, the student should write to the Residence Office, University of New Hampshire, Durham, New Hampshire 03824.

Alumni Association

Those individuals who have received an advanced degree from the University of New Hampshire automatically become members of the Alumni Association. The present membership of the Association exceeds 27,600 men and women who represent New Hampshire College and University of New Hampshire classes from 1896 through the present. Alumni reside in every state of the Union and many foreign countries.

Governed by a Board of Directors of 15 elected and 4 ex officio members, who are the elected Alumni Trustees, the alumni are organized by classes and clubs. Class reunions are held annually. An annual Homecoming Day in the fall provides opportunity for alumni to return to Durham while the University is in session. Other alumni gatherings on campus are also scheduled from time to time during the academic year. There are 50 UNH alumni clubs throughout the United States. A bi-monthly magazine, "The New Hampshire Alumnus," circulates news of students, faculty, alumni, and the University to subscribers. From offices in Alumni House on the campus, the Association's activities are directed by a permanent Director of Alumni Affairs and his staff.

Regulations of the Graduate School

General Regulations

Admission

Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided their undergraduate records are satisfactory. Factors of race, religion, color, and national origin do not enter into the admissions process.

Before entering upon graduate work the applicant must present evidence that he has had the necessary prerequisite training which will enable him to pursue the courses desired. A candidate for admission must have a superior undergraduate record. Where the department in which the candidate plans to do his work so requires, the candidate may be required to take an achievement test. In addition there may be special requirements set up by individual departments or programs. For the individual departmental requirements, see the description under the departmental offerings in this catalog.

A student who desires to register for graduate study must submit to the Dean of the Graduate School the official application for admission to graduate study. Forms for this purpose may be obtained by writing to the Dean of the Graduate School, University of New Hampshire, Durham, New Hampshire 03824. The application must be accompanied by two official transcripts of the student's undergraduate work and of any previous graduate work, and by three letters of reference. Transcripts of applicants who are admitted to graduate study become a permanent part of the University files and will not be returned.

Applications to the University of New Hampshire Graduate School must be accompanied by a non-refundable \$10 application fee.

Students wishing to enroll in the Master of Science for Teachers program must meet one of the following admission requirements: (a) education courses sufficient for certification, (b) three years' experience in teaching, or (c) current full-time participation in teaching.

Completed applications for admission to the Graduate School should be submitted before July 15 for the first semester, before November 15 for the second semester, and before April 1 for the Summer Session to guarantee action before the

Regulations of the Graduate School

respective registration days. Applications will be accepted after the dates mentioned above, provided that the applications are accompanied by complete official transcripts; but it may be necessary to postpone the evaluation of credentials and the determination of requirements until after the registration period. Students wishing to apply for financial aid must submit their applications for admission prior to February 15.

Foreign students applying for admission to the Graduate School must furnish proof of their ability to handle the English language. Such students should take the "Test of English as a Foreign Language" administered by the Educational Testing Service, Princeton, New Jersey. All regularly enrolled graduate students must have a medical history and physical examination report on file with the Director of the University Health Service. Recent graduates of the University of New Hampshire need not file a new set of reports upon being admitted to the Graduate School. Others should obtain the proper forms from the Dean of the Graduate School.

Admission to the Graduate School does not imply admission to candidacy for a degree. No graduate student is admitted to candidacy for a degree until he has been in residence a sufficient length of time to enable his instructors to judge his ability to carry on graduate work. Generally this period of time shall be not less than that required for the completion of 12 credits of graduate work for the Master's degree, and the passing of the qualifying examination and the completion of departmental language requirements for the Ph.D. degree. Admission to candidacy for a degree will be determined by the Dean upon the recommendation of the department concerned. The student will be notified by the Dean, in writing, of the decision made.

A student admitted to graduate study must have his program approved by the chairman of his department or of his guidance committee and the Dean of the Graduate School. Registration is held prior to the beginning of classes each semester and on the first day of Summer Session. Consult the calendar in this catalog for the dates of registration. Graduate students are defined as those who meet the requirements for admission to the Graduate School and are registered for an approved program for graduate credit.

The maximum graduate load allowed is 16 semester credits for a regular semester, seven credits for a six-week Summer Session, and nine credits for an eight-week Summer Session. Only under unusual circumstances will excess credits be allowed, and then only with the approval of the Dean of the Graduate School.

Graduate Credits

Graduate credits may be earned only in courses numbered from 700 through 898, and in the thesis, but graduate credits will not be given in any courses so numbered which are open to freshmen or sophomores. For certain cases graduate credit is allowed for 600 level courses for Master's degree programs.

Also upon recommendation of the department, superior students may be allowed to count credits from up to two 800-level courses toward both a Bachelor's and Master's degree provided the student has been admitted to the Master's program.

Graduate students who desire to do a part of their work during the Summer Session of the University will find graduate courses offered in many departments. Credit in appropriate courses may be used in fulfilling the requirements for an advanced degree. For complete information on the Summer Session, see the Summer Session catalog.

Qualified senior students in the University of New Hampshire may be admitted to the Graduate School, and must have been admitted before taking courses for graduate credit.

Students holding the baccalaureate degree who have not been admitted to the Graduate School, but who wish to register for graduate courses, must receive the approval of the Dean of the Graduate School and of the instructor concerned.

Credits earned in an unclassified status will be applied to a degree program on a selective basis. No more than nine hours earned on campus in an unclassified status may be applied at a later date to the residence or credit-hour requirement for a degree.

An incomplete grade in the Graduate School must be made up within a year after the course was to have been completed. This rule does not apply to the completion of the thesis. The student must meet the special requirements of the department in which he is doing his graduate work, and his program must be approved by his adviser and the Dean of the Graduate School. For these special requirements see the department statements in this catalog.

There are changes being made regarding graduate requirements and catalog material is subject to revision.

Graduate Grades

The three passing grades are: Honors (*H*), High Pass (*HP*), and Pass (*P*). A graduate student receiving nine or more credits with a failing grade (*F*) will normally be required to withdraw from the Graduate School. Students enrolled in Master's programs requiring in excess of thirty credits will be permitted a proportional increase in the amount of failing work. A grade of (*Cr*) (Credit) is given for completed theses and dissertations.

Tuition

The tuition is \$630 a year for residents of New Hampshire and \$1,575 a year for non-residents. A student, though he may be 21, will not be recognized as a resident by the University unless he can clearly establish that his residence in New Hampshire is for some purpose other than the temporary one of obtaining an education at the University.

Tuition rates in the Summer Session and for courses offered by the University Extension Service are listed in their respective catalogs. It should be noted that liberal financial aid is available to graduate students.

Any student registering for 8 credits or more per semester will pay the full semester tuition. Any student registering for fewer than 8 credits per semester shall pay \$25. per credit hour. Graduate assistants may be exempted from payment of tuition.

A doctoral student who is registered for fewer than eight credits and is pursuing research for the dissertation shall pay by the credit hour, plus a research charge of \$50 a semester. If registered for research only, the charge of \$50 a semester will be applicable and will carry with it the privilege of attending seminars.

When a doctoral candidate completes his requirements *in absentia*, a charge of \$50 for the privilege of taking the final examination must be paid six weeks before the conferring of the degree. A Memorial Union assessment of \$6.00 per semester must be paid by each student.

The immediate families of members of the University staff may register as full or part-time students in the Graduate School at one-half the current tuition or course rate. They are required, however, to pay the full research fee, if doctoral students.

The University reserves the right to adjust charges for such items as tuition, board, and room rent from time to time. Such changes will be held to a minimum and will be announced as far in advance as feasible.

Regulations of the Graduate School

Assistantships, Scholarships, and Fellowships

Graduate Assistantships

Approximately 200 graduate assistantships are available each year. Such assistantships are awarded only to superior students. The reappointment of a graduate assistant is contingent on the maintenance of a high level of scholarship. The service required of the graduate assistant may be in the nature of teaching assistance, research assistance, or general service.

There are two categories of regular assistantships available. The recommended conditions of employment for each category are as follows:

1. \$2,400 per academic year for an approved schedule of part-time services to the department. Normal academic program: 9 semester hours per semester. Exemption from payment of tuition may be granted for the academic year and the following Summer Session on recommendation of the department chairman.
2. \$3,360 (10 months at \$240, 2 months at \$480) for the fiscal year for part-time service during the academic year, and full-time during the summer with one month vacation. Normal academic program: 9 semester hours per semester. Exemption from payment of tuition for the regular academic year may be granted on the recommendation of the department chairman.

Inquiries regarding assistantships should be addressed to the chairman of the department concerned. Scholarships and fellowships ranging in value from remission of tuition to over \$5,000 per year are available to qualified graduate students.

Tuition Scholarships

Up to fifty superior students may be granted academic-year tuition scholarships. These awards are subject to the maintenance of a high scholastic record in the Graduate School. Foreign students will be considered for these scholarship awards.

Up to thirty superior students, who have been regularly admitted to the Graduate School, may be granted tuition scholarships for the Summer Session.

Project Assistantships

Project Assistantships in limited number are also available. They are worth \$3,030 per academic year.

University of New Hampshire Fellowships

A limited number of three-year fellowships, called University of New Hampshire Fellowships, are awarded to outstanding doctoral students. Each recipient is given an opportunity to spend the first year in full-time study, the second year as a teaching assistant, and the third year as a research assistant. The stipends for this program are \$2,400 for the first year, \$2,600 for the second year, and \$2,800 for the third year. In addition, the award provides \$680 support for each of two summers, waiver of tuition, and an annual allotment of \$500 each for as many as two dependents.

Alumni Fellowships

A limited number of Alumni Fellowships are available to students following a graduate program in the social sciences and humanities. The stipend is \$3,000 per academic year plus tuition waiver.

Traineeships

Traineeships sponsored by the National Science Foundation are available to outstanding students studying for the Master's or Ph.D. degree in the various science and engineering fields. The basic stipends (for 12 months of study) range from \$2,400-\$2,800 plus free tuition and \$500 per dependent. — Open to U. S. citizens only.

National Defense Education Act (NDEA Title IV) Fellowships

National Defense Education Act (NDEA Title IV) fellowships are available to highly qualified students who are studying for the Ph.D. degree and are interested in college teaching careers. Academic year stipends range from \$2,000 to \$2,400 plus free tuition and \$400 per dependent. An additional stipend of \$400 plus \$100 per dependent is available for summer study. — Open to U. S. citizens only. Graduate students also are eligible for awards granted by other national agencies and foundations.

Martin Luther King Scholarship

There are two Martin Luther King Scholarships reserved for graduate students. They are to assist members of minority groups. Stipend amounts vary according to financial need.

Dissertation Fellowships

One-year dissertation fellowships are available, providing a \$3,000 stipend. Because no classes are attended, a tuition waiver is not included.

Summer Fellowships

Twenty-five Summer Fellowships for Teaching are available for students who have held teaching assistantships during the previous academic year. The stipend for summer study is \$680.

Information and application forms for all of the above scholarship and fellowship programs may be obtained from the Dean of the Graduate School.

Properly qualified scholars, who may temporarily desire the privileges of the library and research facilities of the University, and who are not candidates for a degree, may, upon recommendation of the Dean of the Graduate School and the approval of the President of the University, be appointed Honorary Fellows without stipend. Honorary Fellows shall not be required to pay any charges except possibly the cost of unusually expensive supplies or equipment.

Graduate Degree Programs

Master of Science

Animal Sciences
Biochemistry
Biology
Botany
Chemical Engineering
Chemistry
Civil Engineering
Electrical Engineering
Entomology
Forest Resources
Genetics
Geology
Home Economics
Mathematics
Mechanical Engineering
Microbiology
Music Education
Physics
Plant Science
Resource Economics
Soil and Water Science
Zoology

Master of Arts

Economics
English
French
German
History
Music
Political Science
Psychology
Sociology
Spanish

Master of Arts in Teaching

Department of Education

Master of Science for Teachers

Chemistry
English
French
German
Mathematics
Physics
Spanish

Master of Agricultural Education

Department of Agricultural Education

Master of Business Administration

Whittemore School of Business
and Economics

Master of Education

Department of Education

Master of Public Administration

Department of Political Science

Doctor of Philosophy

Biochemistry
Botany
Chemistry
Genetics
History
Mathematics
Microbiology
Physics
Plant Science
Psychology
Sociology
Zoology

Requirements for Master's Degree

For the degrees of Master of Arts, Master of Science, Master of Agricultural Education, Master of Business Administration, and Master of Public Administration, at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis, numbered 800-898. Courses numbered 600-699 cannot be used towards these Master's degrees if the courses are given in the department awarding the degree. No more than 12 credits will be permitted in courses numbered 600-699. The major department will prescribe for its students the courses which make up the degree program. Somewhat different requirements obtain for the Master of Science for Teachers degree and it is recommended for this degree, as well as for all other Master's degrees, that the appropriate departmental section of the catalog be consulted.

A student will normally spend at least one calendar year, or the equivalent, in satisfying the requirements for the degree. No more than 12 credits, not including thesis, may be earned off campus. Of these 12, only 6 may be from another graduate school.

All graduate work for any Master's degree must be completed in not more than six years from the time of registration for the first work taken for the degree.

In any department or program requiring a final examination for the Master's degree, the examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examinations for the Master's degree, and the time of these examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date in the year in which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School. Oral examining committees, when required and not otherwise provided for, will be appointed by the Dean of the Graduate School, upon the recommendation of the department concerned. The Dean of the Graduate School is, *ex officio*, a member of all examining committees.

A student may present for credit a maximum of six credits earned at another graduate school provided that these credits are of a grade of at least B or the equivalent. These will be applied toward the degree only if approved by the major department and the Dean of the Graduate School.

Thesis

A thesis may be required of candidates for the Master of Arts or the Master of Science degrees. Consult the departmental statement for thesis requirements. The thesis must be approved by a committee, comprising the instructor under whose direction it was written and two other members of the Graduate Faculty selected by the department chairman and approved by the Dean of the Graduate School.

Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed.

The number of thesis credits may vary from six to ten, subject to the approval of the student's adviser. No thesis credit shall be given until the completed thesis has been approved by the committee on the thesis. No letter grade shall be given for the thesis, but its satisfactory acceptance will be recorded with a Cr (credit).

Regulations of the Graduate School

The student should obtain from the Graduate School office the latest mimeographed regulations for the form and typing of thesis.

Whenever a thesis is printed, it must be designated as having been accepted as a Master's thesis by the University of New Hampshire.

Two copies of the approved thesis, ready for binding, shall be turned in to the Graduate School office not less than two weeks before Commencement, together with a receipt for the binding fee from the University Bookstore. Most departments require one copy of the thesis in addition to the above-mentioned two copies. (See departmental requirements in this catalog.)

Requirements for the Doctor's Degree

The degree of Doctor of Philosophy is conferred on qualified candidates: who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation. The degree of Doctor of Philosophy is essentially a research degree. It is not given merely for the completion of course credits. Graduate programs leading to the degree of Doctor of Philosophy are offered in Biochemistry, Botany, Chemistry, Genetics, History, Mathematics, Microbiology, Physics, Plant Science, Psychology, Sociology, and Zoology.

All resident predoctoral students must register each semester until requirements for the degree have been completed. The minimum requirement for the doctorate is three years beyond the bachelor's degree. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the guidance committee and the Dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the Dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities may be advantageous.

After September 1969, all graduate work for the doctorate must be completed by the end of the fifth academic year following that in which the student completes the requirements for advancement to candidacy.

General Requirements

A student working for the Ph.D. degree must earn a passing grade in all the courses required by his guidance committee. Certain courses may be taken for audit.

When the student declares his intention to proceed to candidacy for the degree of Doctor of Philosophy, the department of intended major concentration shall notify the Dean of the Graduate School, who then, upon recommendation of the department, will appoint a guidance committee. This committee will assist the student in outlining his program and in preparing him for his qualifying examination. To prepare him for the qualifying examination and successful pursuit of his research and course work, the guidance committee may require him to take additional course work, with or without credit.

At the time of application by the student for the qualifying examination, a doctoral committee will be appointed to supervise the qualifying and final examinations

Explanation of Course Numbering System

and to pass on the dissertation. This committee shall be nominated by the department of major concentration and appointed by the Dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments, and the Dean of the Graduate School, ex officio.

The qualifying examination may be written, oral, or both. This examination will test: (1) the student's general knowledge in his major and minor work and (2) his fitness for engaging in research, particularly in the subject proposed for the dissertation. The results of the examination will be communicated by the chairman of the major department to the Dean of the Graduate School.

The student may not be advanced to candidacy for the Ph.D. until he has passed the qualifying examination and such language or proficiency requirements as are deemed desirable by the major department. The proposed subject of the student's dissertation must be declared at the time of application for advancement to candidacy.

Resident full-time members of the University of New Hampshire faculty with rank of Assistant Professor or higher may not be admitted to candidacy for the Ph.D. at this University.

The dissertation must be a contribution to knowledge, embodying the results of significant and original research, and a mature and competent piece of writing.

A copy of the completed dissertation must be made available to the Dean of the Graduate School and to the members of the examining committee two weeks before the final examination date. Following the examination and two weeks prior to Commencement, two copies of the approved dissertation, ready for binding, shall be turned in to the Graduate Office, together with a receipt for the binding fee from the University Bookstore. Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. If the material presented in the dissertation is published, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

The final oral examination is conducted by the doctoral committee and is intended to give the candidate an opportunity to defend his dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. The final examinations must be completed at least two weeks prior to the date of receiving the degree. After consultation with the major department, the Dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate's performance by a majority vote.

Explanation of Course Numbering System

The title, in capital letters, and the Arabic numeral designate the particular course. Odd numerals indicate courses normally offered in the first semester; even numerals indicate courses normally offered in the second semester. Numerals enclosed in parentheses indicate that course is repeated in the semester following. Thus course 401 (401) is offered in the first semester and is repeated in the second semester. Parentheses are also used to designate courses out of semester sequence. For example, (404) indicates an even-numbered course offered in the first semester.

Regulations of the Graduate School

The course description is followed by the prerequisites, if any, and the number of semester credits the course will count in the total required for graduation. Laboratory periods are usually two and one-half hours in length, lectures either 50 minutes or 80 minutes in length.

If the course numerals are connected by a hyphen, the first semester, or its equivalent, is a prerequisite to the second semester. If the numerals are separated by a comma, properly qualified students may take the second semester without having had the first.

IBM Key Codes

The following numbers are used extensively in machine-processed data to identify both undergraduate and graduate programs offered at the University. An asterisk preceding the number identifies those departments which offer graduate programs.

College of Liberal Arts

- 40 Liberal Arts non-departmental
- *41 Biological Sciences Division
- 42 Education Division
- 43 Humanities Division
- 44 Physical Sciences Division
- 45 Social Sciences Division
- 46 The Arts
- *47 Microbiology
- *48 Education
- *49 English
- 50 Geography
- *51 Geology
- *52 Government
- *53 History
- 54 Nursing
- 55 Foreign Language and Literature
- *56 French
- *57 German
- 58 Greek
- 59 Italian
- *60 Latin
- 61 Russian
- *62 Spanish
- *63 Music
- 64 Music Education
- 65 Occupational Therapy
- 66 Philosophy
- *67 Psychology
- *68 Sociology
- 69 Speech and Drama
- *70 Zoology

College of Agriculture

- 20 Agriculture non-departmental
- *21 Resource Economics
- *22 Agricultural and Extension Education
- *23 Soil and Water Science
- *25 Animal Sciences
- *26 Biochemistry
- *27 Botany
- *29 Entomology
- *30 Forestry
- *31 Home Economics
- *32 Plant Sciences

College of Technology

- 79 Technology non-departmental
- *80 Chemical Engineering
- *81 Chemistry
- *82 Civil Engineering
- *83 Electrical Engineering
- *84 Mathematics
- *85 Mechanical Engineering
- *86 Physics

Whittemore School of Business and Economics

- *71 Business Administration
- *72 Economics
- 73 Secretarial Studies
- 74 Hotel Administration

Departmental Requirements and Course Descriptions

Agricultural Education (22)

Chairman: *William H. Annis*

ASSOCIATE PROFESSORS: William H. Annis, Paul A. Gilman, Jesse James

The degree of Master of Agricultural Education is designed for teachers of agriculture, county Cooperative Extension Service personnel, and others in adult education. A comprehensive examination will be required of all candidates for this degree.

791. Planning for Teaching

The organization of materials of instruction to meet group and individual needs. Techniques of instruction, planning for teaching, the function of consulting committees, working with youth groups, and program evaluation. This course is scheduled concurrently with Education 658, 659 and 694. Prerequisite: Agricultural Education 650 or permission of instructor. 4 credits.

795. Preparation for Conducting and Supervising Adult Education Programs

The techniques of adult education in terms of: identifying needs, program planning, methods of teaching, supervision, and evaluation. Prerequisite: Agricultural Education 650 or permission of instructor. 4 credits.

797. Advanced Methods and Materials of Instruction

The organization of instruction to meet individual and student needs; development and use of resource files and instructional materials. Evaluation in teaching vocational-technical education. Open to teachers of vocational-technical education and others by permission of instructor. 4 credits.

798. Concepts of Vocational-Technical Education

The development of vocational-technical education in the United States with emphasis on the socio-economic influences responsible for its establishment. The federal and state requirements for programs of the secondary and post-secondary schools will be discussed. Coordination of programs with general education and other vocational fields. 4 credits.

Agricultural Education

801. Advanced Methods in Agricultural Mechanics Instruction

Agricultural mechanics problems and how to approach them in the high school as a part of the course of study in vocational agriculture. The physical setup, as well as the processing of supplies and equipment, methods of supervision and direction of agricultural-mechanics projects, and the preparation and presentation of demonstrations. Mr. Gilman. 2 credits.

802. Methods of Teaching Power and Machinery in Agricultural Education

Teaching the servicing and maintenance of the agricultural power and machine complex as it relates to the production and non-production phases of vocational agriculture. The development of teaching plans, techniques of instruction, and the development of multimedia teaching units will be stressed. 3 credits.

804. Program Planning in Agricultural Education

The basic problems, principles, and procedures in the process of program planning in vocational agriculture and extension. 2 credits.

805. Planned Agricultural Experience Programs in Vocational Agriculture

Development of cooperative relations, selection and development of individual programs with the students, and the supervision and evaluation of such programs. 2 credits.

806. Preparation and Use of Visual Aids for Agricultural Education

The purpose of visual aids and the kinds best adapted to use in the program, together with their preparation and use. 2 credits.

807. Organization and Supervision of Youth Organizations

The purposes and organization of youth organizations, establishing the local organization, planning and developing a program of work, ways and means of improving the local organization, and methods of evaluation. 2 credits.

809. Community Organization and Public Relations

The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their membership to the general welfare of the area and the development of a public relations program. 2 credits.

895, 896, 897. Investigations in Agricultural Education

Individual study problems in various phases of agricultural education. Prerequisite: permission of staff. 2 credits.

899. Master of Agricultural Education Thesis

6-10 credits.

Animal Sciences (25)

Chairman: *W. C. Skoglund*

PROFESSORS: Fred E. Allen, Hilton C. Boynton, Walter M. Collins, Nicholas F. Colovos, William R. Dunlop, Richard C. Ringrose, Winthrop C. Skoglund.

ASSOCIATE PROFESSORS: Alan C. Corbett, James B. Holter, Herbert C. Moore, Gerald L. Smith, Richard G. Strout, Samuel C. Smith

ASSISTANT PROFESSORS: Arnold K. Fowler, Joseph T. Riker, III

To be admitted to graduate study in Animal Sciences an applicant is expected to have had sufficient undergraduate training in the basic biological sciences to qualify for special work in this field. A thesis is required and a candidate for the Master's degree shall pass an oral examination covering his graduate courses and thesis.

701. Physiology of Reproduction

A study of physiology, embryology, endocrinology, reproduction, and lactation in domestic animals. Mr. Fowler. 3 lectures; 1 laboratory; 4 credits.

705. A Review of Animal Science

The principles and practices relating to the feeding, breeding, selection, and management of beef cattle, horses, sheep, and swine. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

706. A Review of Dairy Science

Subject matter covering the principles and practices relating to the latest information on dairy cattle breeding, feeding, and management, and the processing and marketing of milk and its products. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

707. A Review of Poultry Science

The principles and practices relating to the latest information on poultry breeding, feeding, diseases, and management. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

708. Animal Genetics

Mendelian and quantitative inheritance in animals. Principles and systems of selection. Mr. Collins. Prerequisite: one course in genetics or permission of instructor. 2 lectures; 1 laboratory; 4 credits.

710. Ruminant Nutrition

Basic ruminant nutrition and feeding management, including the feeding of young ruminants, with the objective of economical milk production. Mr. Holter. 2 lectures; 1 laboratory; 3 credits.

711-712. Investigations in Dairy, Livestock, Poultry

1. Genetics

Mr. Gerald Smith, Mr. Collins, Mr. Boynton.

Animal Sciences

2. Nutrition

Mr. Gerald Smith, Mr. Ringrose, Mr. Colovos, Mr. Holter, Mr. Riker.

3. Management

Mr. Skoglund, Mr. Gerald Smith, Mr. Boynton.

4. Diseases

Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. Samuel Smith.

5. Products

Mr. Gerald Smith, Mr. Moore.

6. Light Horsemanship

Mrs. Briggs, Mr. Riker.

7. Physiology

Mr. Fowler, Mr. Riker.

An opportunity is given for the student to select a special problem in any of the fields listed under the guidance of the instructor. Elective only after consultation with the instructor in charge. Hours to be arranged. 1-3 credits. May be repeated.

801. Advanced Animal Breeding

Practical breeding problems with beef and dual-purpose cattle, sheep, horses, and hogs. The genetic principles important to successful livestock production. Mr. Gerald Smith. 2 lectures; 1 laboratory; 3 credits.

802. Meats, Livestock Markets, and Products

The essential factors in meat selection, cutting, curing, and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Mr. Gerald Smith. 3 lectures; 1 laboratory; 4 credits.

803. Advanced Animal Nutrition

Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Colovos. 3 credits.

804. Advanced Dairy Cattle Breeding

The analysis and formulating of breeding programs, principles of milk secretion, and factors influencing the quantity and quality of milk. Mr. Boynton. 2 lectures; 1 laboratory; 3 credits.

805-806. Avian Microbiology

The disease process (acute or chronic) in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Physiological and cytopathological changes in tissue culture. Mr. Dunlop, Mr. Strout, and Mr. Corbett. Prerequisite: Animal Science 612 or the equivalent. 3 credits.

807-808. Avian Histopathology

First semester: general histopathology. Second semester: the special histopathology of common diseases with emphasis on correlation of light and electron microscopy of tumors and tumor formation. Mr. Dunlop and Mr. Strout. Prerequisite: histology or the equivalent. 3 credits.

809-810. Advanced Poultry Nutrition

Metabolism and the physiology of digestion with emphasis on nutrient needs and deficiency diseases of poultry. Analysis of recent experimental research and current feed problems. Mr. Ringrose. 3 credits.

811. Quantitative Genetics and Animal Improvement

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prerequisite: 1 course each in genetics and statistics. 3 credits.

897-898. Animal Science Seminar

A survey of recent literature and research in the animal sciences. Staff. 1 credit. May be repeated.

899. Thesis

Hours and credits, from 6-10, to be arranged.

Biochemistry (26)

Chairman: *Edward J. Herbst*

PROFESSORS: Donald M. Green, Edward J. Herbst, Miyoshi Ikawa, Arthur E. Teeri

ASSISTANT PROFESSORS: Gerald L. Klippenstein, James A. Stewart

Students admitted to graduate study in the Department of Biochemistry should have completed basic courses in chemistry, biological sciences, mathematics, and physics. The candidate for the Master of Science degree will be required to prepare a thesis, and to pass an oral examination on the thesis and on graduate courses prescribed for the degree program.

The Doctor of Philosophy degree candidate will be required to complete a dissertation on original research in biochemistry and to pass examinations supervised by the Doctoral Committee. Each candidate will be expected to demonstrate a broad basic knowledge of the field of biochemistry and to pass reading proficiency examinations based on the biochemical literature in two foreign languages, usually German and French.

656. Physiological Chemistry and Nutrition

An introductory biochemistry course with emphasis on human physiological chemistry and nutrition. The laboratory includes a study of procedures basic to chemical methods used in medical diagnostic work. Mr. Teeri. Prerequisite: satisfactory preparation in organic chemistry. 3 lectures; 1 laboratory; 4 credits.

751. Principles of Biochemistry

The fundamental principles of biochemistry with emphasis on the chemical properties, metabolic pathways, and functions of carbohydrates, lipids, and nitrogenous compounds. Mr. Herbst, Mr. Ikawa, and staff. Prerequisite: One year of organic chemistry or permission of instructor. 4 lectures; 1 laboratory; 4 credits.

Biochemistry

752. Topics in Biochemistry

A detailed consideration of metabolism and of current developments in biochemistry. Staff and guest lecturers. Prerequisite: Biochemistry 751. 2 lectures; 2 credits.

762. Plant Metabolism

The function, occurrence, synthesis, and degradation of plant constituents. Major emphasis is placed on respiration and photosynthesis and their relationships to the metabolism of lipids and nitrogen compounds. Mr. Routley. Prerequisite: general biochemistry. 2 or 4 credits.

770. Biochemical Genetics

The biochemical mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochemistry 751 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

795, 796. Investigations in Biochemistry

Staff. Prerequisite: permission of instructor. Subject matter and hours to be arranged. 2 credits.

811. Biochemistry of Lipids

The chemistry, metabolism, and function of lipids. Mr. Smith. Prerequisite: general biochemistry. 2 credits.

832. Biochemistry of Carbohydrates

The chemistry, metabolism, and function of carbohydrates and related substances with emphasis on the polysaccharides. Mr. Ikawa. Prerequisite: general biochemistry. (Alternate years; not offered in 1969-70.) 2 credits.

842. Biochemistry of Development

An examination of the biochemical events underlying embryonic development and cellular differentiation. Special emphasis will be placed on the role of nucleic acid and protein synthesis in regulating these processes. Mr. Stewart. Prerequisite: general biochemistry. 2 lectures; 2 credits.

850. Physical Biochemistry

The physical chemistry of biological molecules with emphasis on the structure and properties of proteins. Beginning with the physico-chemical properties of water and the amino acids, discussion will proceed to the primary structure, conformation, and interactions of proteins. Included will be a consideration of the theory and applications of physical methods, such as X-ray diffraction, optical rotation, spectra, sedimentation, and light scattering. Mr. Klippenstein. Prerequisite: physical chemistry and general biochemistry. 2 lectures; 2 credits.

852. Advanced Biochemistry Laboratory

Application of chemical and physical techniques to the purification and characterization of proteins and nucleic acids. Separation methods including vari-

ous types of chromatography and electrophoresis will be used. Ultracentrifugation, spectroscopy, and viscometry will be among the techniques employed to study macromolecular structure. To be taken in conjunction with Biochemistry 850. Mr. Klippenstein. 2 laboratories; 2 credits.

897, 898. Biochemistry Seminar

Presentation and discussion of recent investigations. Mr. Herbst and staff. Prerequisite: permission of the Department Chairman. 0 credit.

899. Master of Science Thesis

To be arranged. 6-10 credits.

999. Doctoral Research

Biology (41)

Chairman of Committee: *Paul A. Wright*

Students admitted to graduate study in Biology must have completed an undergraduate major in Biology or in some field of the biological sciences. Suitable training in the physical sciences is also necessary. Students who lack undergraduate training in any of the fields of the biological sciences may be required to complete certain courses in these fields which do not carry graduate credit before they are admitted to candidacy for a degree.

Graduate work in Biology is under the direction of a committee consisting of the chairmen of the departments of Botany, Entomology, Microbiology, and Zoology. This committee shall determine, in light of the student's objectives, courses and requirements to be met by the candidate. Candidates for the Master's degree in Biology shall pass a written examination covering their general preparation in the field. A student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree.

612. Invertebrate Biology for Science Teachers

A study of readily available forms, principally insects, which have particular application for use in school science courses, concentrating upon living organisms in both field and laboratory. Mr. Schaefer. Prerequisite: two biology courses or permission of instructor. 4 credits.

791. Biology-Education. Problems in the Teaching of High-School Biology

Objectives and methods of teaching, selection and organization of materials, preparation of visual aids, setting up of aquaria and other projects. The use of the field trip as a tool in teaching high school biology. Mr. Schaefer. Prerequisite: two years of biological sciences and Principles of Teaching. 4 credits.

For listings of other courses see: Botany, Entomology, Microbiology, and Zoology.

Botany

Botany (27)

Chairman: *Thomas Furman*

PROFESSORS: *Stuart Dunn, Albion Hodgdon, Charlotte Nast, Avery Rich, Mathias Richards, Richard Schreiber*

ADJUNCT PROFESSOR: *Alex Shigo*

ASSOCIATE PROFESSOR: *Thomas Furman*

ASSISTANT PROFESSOR: *Arthur Mathieson*

Students admitted to graduate study in Botany are expected to have had adequate preparation in basic botany courses and in the physical sciences. The candidate for the Master of Science degree will be required to defend a thesis based on field or laboratory research. Students who are working toward the Doctor of Philosophy degree may be asked to demonstrate knowledge of one or two foreign languages or a cognate field, such as statistics, as an equivalent. The doctoral candidacy follows a comprehensive examination, and includes the defense of a thesis which is a substantial contribution to knowledge. The Department's areas for graduate study include: Plant Physiology, Mr. Dunn; Plant Ecology, Mr. Furman; Systematic Botany, Mr. Hodgdon; Phycology-Biological Oceanography, Mr. Mathieson; Plant Pathology, Mr. McFadden, Mr. Rich, and Mr. Shigo; Plant Morphology and Anatomy, Miss Nast; Mycology, Mr. Richards; Cytology, Mr. Schreiber.

706. Plant Physiology

Structure and properties of cells, tissues, and organs; absorption and movement of water; metabolism; growth and irritability. Mr. Dunn. Prerequisite: Botany 411 or Botany 503 and one year of chemistry. 3 lectures; 2 laboratories; 4 credits.

721. Freshwater Phycology

Identification, classification, ecology, and life histories of the major groups of freshwater algae. Periodic field trips will be scheduled throughout the semester. Mr. Mathieson. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. Alternate years: not offered in 1969-70.

722. Marine Phycology

Identification, classification, ecology and life histories of the major groups of marine algae. Particular emphasis will be placed upon the benthonic marine algae of New England. Laboratories will include field trips during the latter portion of the course. Mr. Mathieson. Prerequisite: Botany 411 or Botany 503. 3 lectures; 2 laboratories; 4 credits.

723. Introduction to Biological Oceanography and Marine Ecology

The distribution, abundance, and growth of marine plants in relation to their environment: chemical, physical, and biological. The students will be expected to attend regular, planned field trips and to conduct an independent research project. Mr. Mathieson. Prerequisite: Botany 722, Zoology 715, or permission of the instructor. 2 lectures; 1 laboratory and field trips; 4 credits. Alternate years: offered in 1969-70.

732. Cytology

The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Schreiber. Prerequisite: one year each of the biological sciences and of chemistry. 3 lectures: 1 seminar: 4 credits.

741. Plant Autecology

The interaction of the individual plant with its environment, including such factors as earth, air, fire, and water: and the resultant processes of symbiosis, adaptation, and evolution. Mr. Furman. Prerequisite: Botany 506 or permission of instructor. 1 lecture: 1 colloquium: 1 laboratory: 4 credits. Alternate years; offered in 1969-70.

742. Plant Synecology

The structure, development, and causes of distribution of plant communities. Methods of analysis and interpretation of field data. Laboratories include field trips on shared-cost basis. Mr. Furman. Prerequisite: Botany 506 or to be taken concurrently: or Forestry 425. 2 lectures: 1 outdoor laboratory: 4 credits.

751. Plant Pathology

The nature of disease in plants: the symptomatology, etiology, and classification of plant diseases. Mr. Rich. Prerequisite: Botany 411 or Botany 503, or equivalent. 2 lectures: 2 laboratories: 4 credits.

752. Mycology

Studies of the parasitic and saprophytic fungi, their growth, reproduction, and identification. Mr. Richards. 1 lecture: 2 laboratories: 4 credits.

753. Forest Pathology

Forest and shade tree diseases: principles, etiology, epidemiology, and control. Mr. Pawuk. Prerequisite: Botany 411 or Botany 503, or equivalent. 2 lectures: 2 laboratories: 4 credits.

754. Principles of Plant Disease Control

Exclusion, eradication, protection, and immunization, and the specific practical methods used to control plant diseases. Mr. Rich. Prerequisite: Botany 751 or 753. 1 lecture: 2 laboratories: 4 credits. Alternate years; offered in 1969-70.

758. Plant Anatomy

The anatomy of vascular plants with special emphasis upon tissue development and structure. Miss Nast. Prerequisite: Botany 411 or Botany 503. 2 lectures: 2 laboratories: 4 credits.

762. Morphology of the Vascular Plants

The life histories and evolution of the extinct and living vascular plants, including comparisons of general structure and sexual organs. Miss Nast. Prerequisite: Botany 411 or Botany 503. 2 lectures: 2 laboratories: 4 credits. (Alternate years; not offered in 1969-70.)

765. Microtechnique

A methods course in embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Miss Nast. Prerequisite: Botany 411 or Botany 503, permission of instructor. 2 lectures: 4 hours of laboratory: 4 credits.

Botany

767. Advanced Systematic Botany

The principles and rules of plant classification and nomenclature; study of plant families, field and herbarium work. Mr. Hodgdon. Prerequisite: Botany 566. 1 lecture; 1 colloquium; 1 laboratory (full afternoon); 4 credits. (Alternate years; offered in 1969-70.)

799. Botany Seminar

Presentation and discussion of oral reports on research with practice in use of visual aids. Participation by all resident departmental majors. Botany Club in charge. 1 hourly session. 0 credit.

805. Advanced Plant Physiology

Plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, and growth regulator effects. Mr. Dunn. Prerequisite: Botany 706 or equivalent, or adequate preparation in the physical sciences. Conferences, laboratory, and assigned reading. 3 or 4 credits. (Alternate years; offered in 1969-70.)

822. Advanced Marine Phycology

Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussions, assigned reading, and laboratory. Mr. Mathieson. Prerequisite: Botany 722 or its equivalent. 4 credits. (Alternate years; not offered in 1969-70.)

830. Morphogenesis

The study of form and development as affected by internal and external factors. Miss Nast. Prerequisite: Botany 758 and 762. 2 recitations of 2 hours each. 4 credits. (Alternate years; offered in 1969-70.)

851. Advanced Plant Pathology

Advanced theories and methods in plant pathology. Mr. McFadden. Prerequisite: Botany 751 or 753 and permission of professor. Assigned reading, conferences, and laboratory. 4 credits. (Alternate years; offered in 1969-70.)

861. Plant Geography

The distribution of plants, a consideration of vegetation types and floras, and problems of endemism with emphasis on North America; the major influential factors such as geologic, climatic, edaphic, and biotic, including man's activities. The major contributions from Humboldt to the present time. Mr. Hodgdon. Prerequisite: permission of Professor. 1 lecture; 1 colloquium of 2 hours; field trips; 4 credits. (Alternate years; offered in 1969-70.)

895-896. Investigations in (1) Systematic Botany, (2) Plant Physiology, (3) Plant Pathology, (4) Plant Anatomy, (5) Plant Ecology, (6) Mycology, (7) Cytology, (8) Phycology, (9) Botanical Teaching, (10) Morphology
Elective only upon consultation with the Botany Department Chairman and the appropriate professor. Staff. Hours to be arranged. 2-6 credits.

899. Master of Science Thesis

6-10 credits.

999. Doctoral Dissertation

Business Administration (71)

Dean: *Jan Clee*

PROFESSORS: John A. Beckett, John A. Hogan, John J. Korbel, Dwight R. Ladd, Sam Rosen, Kenneth J. Rothwell

ASSOCIATE PROFESSORS: Allan J. Braff, Jan E. Clee, Herman Gadon, James O. Horrigan, Manley R. Irwin, Donald C. Marschner, Robin D. Willits, Dwayne E. Wrightsman

ASSISTANT PROFESSORS: Thomas W. Bolland, Allan R. Cohen, Lawrence P. Cole, William R. Hosek, R. Stephen Jenks, Richard L. Mills, Robert C. Puth, James H. Schulz, John Terninko

Whittemore School of Business and Economics

The Whittemore School program leading to the degree of Master of Business Administration is designed to prepare its graduates for professional careers in administration in industrial and other organizations in a rapidly changing world. It provides for knowledge and understanding of management principles and practices through study of (1) the increasing body of relevant knowledge drawn from the behavioral sciences, mathematics, and economics, (2) the existing and emerging processes and institutions of the functional fields of business, and (3) the role of business and other organizations in an increasingly complex and ever-changing society.

Candidates for admission must normally possess a Bachelor's degree from an accredited college or university. Applicants will generally be expected to have completed their undergraduate programs of study with a cumulative academic average of at least 2.5 or the equivalent. In addition, all candidates are expected to take the Admissions Test for Graduate Study in Business (ATGSB) given by the Educational Testing Service. Details concerning times, places, etc., for these examinations may be obtained from Education Testing Service, Box 966, Princeton, N. J. 08540.

The Whittemore School welcomes applicants from any academic discipline, but previous work in mathematics, economics, the behavioral sciences, and the various branches of engineering are of particular relevance to graduate study in Business Administration. Because of the increasing use of mathematical concepts, models, and notation in the practice and study of business administration, applicants should normally have successfully completed one year of college mathematics through an introduction to the calculus.

In all cases, the applicant's entire educational background, relevant experience, references, and professional aims will be considered in the admissions process. Exceptions may be made to any of the foregoing requirements by the Committee on Admissions.

The program leading to the Master of Business Administration degree requires two years of full-time study. The first year of the program consists of separate courses integrated into an overall study of the nature of business administration in a rapidly changing environment. In the first semester, the student will be largely concerned with study of concepts and analytical techniques drawn from the basic disciplines, such as economics, mathematics, psychology, and sociology, which underlie business administration. In the second semester, some work in the behavioral and quantitative areas is continued and courses dealing with the functional areas

Business Administration

of business are introduced. In these courses the concepts and techniques developed in the early part of the year are utilized in dealing with specific business problems.

The second year continues the emphasis of the first year on overall management by requiring all students to complete the integrating course entitled Policy Formulation and Administration. Special attention is also given in the second year to the changing and increasingly complex external environment in which management functions, by requiring all students to complete the course entitled Conceptual Foundations of Business. In addition, the student will select the equivalent of eight semester courses from among those offered in Business Administration and Economics by the Whittemore School and by other colleges and departments of the University. In selecting these courses the student will normally be expected to develop some concentration by taking at least two semester courses but not more than three semester courses in one of the several, designated areas. Where the student elects courses offered by other colleges of the University, such selection requires approval of the Dean of the Whittemore School.

705. Operations Research

Mathematical programming, game theory, inventory, queuing, and scheduling problems, dynamic programming. 4 credits.

711. Corporations

The role of the modern corporation in the economy. Emphasis upon structure of the corporation, the corporate system, combinations, and concentration. Mr. Degler. Prerequisite: Economics 402. 4 credits.

712. Organizational Change

Examination of the process of change in organizations. Consideration of change strategies, the role of the change agent and his relation to the client system. The bases of resistance to change and the problems encountered by internal and external change agents. Readings include theoretical material on influence and attitude change as well as organizational change. Mr. Jenks. Prerequisite: permission of instructor. 4 credits.

713. Interpersonal and Group Dynamics

Intensive experimental study of the dynamics of small groups through the use of the class itself as a Laboratory Study Group. Students examine their own behavior and its effects on others through use of the Laboratory Training Group (T-group) as the major learning tool. The course develops both conceptual ability and behavioral skill in this area. Prerequisite: permission of instructor. Mr. Jenks. 4 credits.

717. Advanced Financial Accounting I

Accounting theory and practice as they contribute to the significance and limitations of the financial statements by which business communicates financial status to interested outsiders. Mr. Horrigan. Prerequisite: permission of instructor. 4 credits.

718. Cost and Management

The effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Topics considered include analysis of cost behavior,

direct and absorption costing, cost-price-volume relationships, distribution costs, transfer pricing, and capital-expenditure analysis. 4 credits.

730. Investment Analysis

An evaluation of capital markets and of analytical techniques useful for security analysis. The following subjects will be covered: securities characteristics, market institutions, yield structures, price-change patterns, intrinsic value analysis, investment timing, and portfolio management. Lectures, outside readings, and security analysis research projects are the main tools of the course. Mr. Horrigan. Prerequisite: some previous work in financial accounting would be extremely helpful. 4 credits.

741. Transportation

The wide range of problems surrounding the American transportation system. The basic economic structure of the transportation industries with particular emphasis on competition among the several modes. Such public policy questions as merger of transportation enterprises and cost-benefit analysis of transportation facilities are considered. While principal emphasis in the course is on freight transportation, the problems of passenger transportation, especially in urban areas, is discussed. Limited attention is given to distribution as a specific function of business enterprise. Lectures and discussions of cases. Two or three short papers and a term paper are required. Mr. Ladd. 4 credits.

750. Marketing Management

The interrelation of marketing with production and finance. Topics include planning and developing the product, testing, brand management, packaging, sales organization, forecasting, and control. Policy formulation and decision making are emphasized. Mr. Marschner. 4 credits.

751. Advertising and Promotion

A theory of promotion: how the modern firm acts to obtain maximum efficiency and effectiveness from the use of the major tools of marketing communication (advertising, personal selling, sales promotion, direct-mail merchandising, publicity), as seen from the point of view of the marketing manager. Some emphasis is also placed upon ethical and moral problems. The course is built upon lectures, classroom discussions, some creative research, and weekly case analyses. Mr. Marschner. 4 credits.

752. Marketing Research

Marketing research as a basis of formulating marketing policies and strategy. Topics include research design, methods of collecting data, planning the investigation, sampling methods, motivation research, advertising research, and consumer research. 4 credits.

753. Comparative Marketing

The identification and analysis of common factors and differences in marketing concepts, systems, techniques, and institutions among various societies and nations in the world today. Conducted by a visiting professor from a Western European university, the course will be comprised largely of lectures and classroom discussions, based upon extensive outside readings from modern marketing literature. Mr. Hansen. 4 credits.

Business Administration

754. Consumer Behavior

The consumer-firm relationship studied in terms of concepts drawn from contemporary, social-science findings, particularly small-group studies, as related to present and prospective marketing activities of a business organization. 4 credits.

755. Advanced Financial Management

Financial policy of the firm with emphasis on solutions to complex problems of cost of capital, leverage, optimal capital structure, capital budgeting, and working capital management. Discussion of abstract models and how they can be modified and applied to concrete situations. Cases may be used. Mr. Wetzel. Prerequisite: permission of instructor. 4 credits.

791. Seminar in Organizations

Investigation by a restricted group of students of specific issues in organization theory and practice. The exact topic will vary from semester to semester as interests develop and opportunities for field study emerge. Mr. Clee. Prerequisite: permission of instructor. 4 credits.

801. Quantitative Analysis

Calculus, difference equations, and matrix algebra with business applications. 4 credits. (Open to full-time Master of Business Administration students only.)

802. Quantitative Analysis

Probability, sampling, inference, regression, econometric models. 4 credits. (Open to full-time Master of Business Administration students only.)

803. Human Behavior in Organizations

To provide students with an understanding of behavioral science concepts and their use in the analysis of interpersonal relationships in organizations and to develop sensitivity to the range of possible human behavior in organizations. 4 credits. (Open to full-time Master of Business Administration students only.)

804. Management Organization

Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. 4 credits. (Open to full-time Master of Business Administration students only.)

806. Financial Management

Concepts and techniques for determining the need for, the acquisition of, and the management of financial resources of the business. 4 credits. (Open to full-time Master of Business Administration students only.)

807. Economic Environment of Business

To provide an understanding of national economic activity including output, income, employment, and price levels and to provide familiarity with present knowledge of the determinants of economic growth and fluctuations. 4 credits. (Open to full-time Master of Business Administration students only.)

808. Marketing

Identification, development, and retention of markets for the goods and services offered by the firm. Attention is given to the dynamics of demand and to the

blending of the marketing mix. 4 credits. (Open to full-time Master of Business Administration students only.)

810. Production Management

Concepts and practices in the planning, supervision, and control of activities concerned with manufacturing the goods and services of the firm. 4 credits. (Open to full-time Master of Business Administration students only.)

811. Conceptual Foundations of Business

Study of the modern corporation as a partly economic, partly legal, and partly social organization, including examination of widely held views about business and views of businessmen about themselves. 4 credits. (Open to full-time Master of Business Administration students only.)

812. Business Policy

A "capstone" course, focused on industries, companies, and other organizations in operation, and studied through case examples, with emphasis on integration of materials covered in prior courses. 4 credits. (Open to full-time Master of Business Administration students only.)

815-816. Financial Reporting and Economic Analysis for Management

An integrated view of accounting and economic analysis. Its objectives are to provide the student with some general models of the firm for planning and reviewing operations and with a wide assortment of analytical techniques for decision making. Mr. Ladd. 4 credits.

861. Control and Information Systems

The concepts of systems, their use in enterprise management, and the role and influence of on-line control systems; the nature and uses of information in management. The course includes materials intended to familiarize the student with software techniques and hardware characteristics related to "information technology." Mr. Beckett. 4 credits.

895. Special Projects and Independent Study

Projects, research, and reading programs in areas required for concentration. Sixty days' advance approval of the student's plan of study by adviser and by proposed instructor required. Staff. 4 credits.

Chemical Engineering

Chemical Engineering (80)

Chairman: *Oswald T. Zimmerman*

PROFESSOR: Oswald T. Zimmerman

ADJUNCT PROFESSOR: Yin-Chau Yen

ASSOCIATE PROFESSOR: Stephen S. T. Fan

ASSISTANT PROFESSORS: David Chittenden, Henry M. Gehrhardt

To be admitted to graduate study in Chemical Engineering an applicant shall be expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies. An entrance examination covering basic subjects in chemical engineering will be given to all entering graduate students before registration. No one will be admitted as a candidate for a degree until he has passed all portions of the entrance examination.

A candidate for the Master's degree in Chemical Engineering may choose either to prepare a thesis, for which up to six credits will be allowed, or to take an equivalent amount of course work. Students who do not prepare a thesis will be required to enroll in Chemical Engineering 890 at their earliest opportunity. These candidates will be required to take a comprehensive oral examination prior to completion of the Master of Science program in place of the customary defense-of-thesis examination.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

Permission of the instructor and consent of the student's adviser are required for enrollment in all Chemical Engineering courses.

607. Physical Metallurgy

The nature of metals, emphasizing the quantum mechanical description of the solidstate and including atomic structure, bonding, historical development of metal theories, elementary zone or band theory, and X-ray diffraction. The microscopic metal system, thermodynamics of metallurgical processes, defects and dislocations, phase relations of pure metals and alloys, microstructure, and physical and thermal treatment of metals. Study of some non-metals. 3 lectures; 1 laboratory; 4 credits.

608. Chemical Engineering Design

The principles of cost engineering, including estimation of plant investment, working capital, operating costs, labor requirements, payout time, and profitability. Value of money, capitalized costs, simple and compound interest, depreciation, taxes and insurance, labor requirements, overhead, financing of chemical enterprises, design of equipment and plants for minimum cost, plant location, transportation, sales cost, equipment cost, and cost indexes. Each class selects one or more problems involving the complete design of a chemical plant. For each problem, the most desirable process must be determined, the site selected, the equipment and plant designed, calculations made for all costs,

profitability and payout time, and a complete report prepared, including the drawings of equipment and plant layout. 1 lecture; 3 laboratories; 4 credits.

701. High Polymers

Principles and practice of high-polymer manufacture, including industrial polymerization methods and equipment design. Laboratory work includes typical polymerization reactions and the physical and chemical testing of various types of plastics and synthetic fibers. 3 lectures; 1 laboratory; 4 credits.

752. Process Dynamics

A basic treatment of process dynamics, including a study of first- and second-order linear processes and their response to step and sinusoidal driving functions. Graphical analysis of the entire control system is included with special emphasis on the optimum design of a stable system. 3 credits.

762. Introduction to Optimization

Optimization techniques applied to functions not described analytically. Search techniques include Fibonacci search, golden-section search, method of steepest ascent, method of contour tangents, and the method of parallel tangents. Stochastic schemes are considered. Advanced techniques for the optimization of objective functions are considered from a qualitative viewpoint. 3 credits.

813. Introduction to Fluid Dynamics

Equations of change for continuous fluids, laminar Newtonian and non-Newtonian flow; ideal fluid flow; boundary layers methods; turbulence. 3 credits.

815. Heat Transfer

Steady-state and transient heat conduction in solids; heat convection; analytic solutions, similarity relations, boundary layer methods; radiation. 3 credits.

816. Diffusive Mass Transfer

Emphasis on the physical aspects of diffusion; theories of diffusion in dilute gases, dense gases, liquids, and solids; surface diffusion; mixing processes. Simultaneous heat and mass transfer. 3 credits.

823. Advanced Chemical Engineering Thermodynamics

A discussion of the multicomponent open system from the engineering viewpoint; the volumetric and phase behavior of pure substances and of multicomponent systems at physical and chemical equilibrium; fugacity and activity; thermal properties of equilibrium, chemically reacting systems; introduction to statistical thermodynamics. 3 credits.

832. Advanced Chemical Engineering Kinetics

Discussion of specialized applied kinetics problems; catalysis; fast reaction and shock tubes; combustion and detonation processes; non-isothermal kinetics; heat and mass transfer in non-equilibrium, chemically reacting systems. 3 credits.

852. Advanced Process Dynamics

An advanced treatment of process dynamics, including higher order processes and nonlinear processes. Special attention is given to representing a complex process by differential equations, linearizing nonlinear elements, and adequately controlling the entire system. 3 credits.

Chemical Engineering

871. Introduction to Nuclear Engineering

The scientific and engineering development of nuclear reactors, including basic binding-energy physics, nuclear stability, radioactivity, the elements of nuclear-reactor theory, and the engineering problems of heat transfer, fluid flow, materials selection, and shielding. This course is intended for any interested graduate students. 3 credits.

872. Nuclear Chemical Technology

The design, construction, and operation of nuclear process equipment, including reactors and associated chemical processing facilities, and isotope separations plants. The technology of applied radiation chemistry. Intended primarily for graduate students in chemical engineering. 3 credits.

890. Literature Report

Instruction in the use of the library for chemical engineering research. This course will culminate in the preparation of a literature report on a topic of mutual interest to the student and the chemical engineering faculty. 1 credit.

895, 896. Graduate Independent Study

Directed reading or investigation at the advanced level on topics or problems in chemical engineering. 2-4 credits.

897, 898. Graduate Seminar

Discussion on topics of interest to graduate students and staff; reports of research progress; invited lectures by outside speakers. 0 credit.

899. Master's Thesis

Original investigations in chemical engineering. 1-6 credits.

Chemistry (81)

Chairman: *Alexander R. Amell*

PROFESSORS: Alexander R. Amell, Albert F. Daggett, Helmut Max Haendler, Paul R. Jones, Robert E. Lyle Jr., Frank L. Pilar

ASSOCIATE PROFESSORS: Kenneth K. Anderson, David W. Ellis, Gloria G. Lyle, Albert K. Sawyer, Jacob J. Uebel, James H. Weber, Charles M. Wheeler Jr.

ASSISTANT PROFESSORS: Charles V. Berney, Colin D. Hubbard, James D. Morrison, Charles W. Owens

The Department of Chemistry offers programs leading to three graduate degrees: Doctor of Philosophy, Master of Science, and Master of Science for Teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting the new student's graduate work at the proper level. These examinations will be offered at the beginning of the semester in September and in February.

The faculty of the Chemistry Department feels that the experience of teaching is a valuable part of the training of the graduate student. Therefore, all graduate students who are Doctors of Philosophy or Masters of Science candidates will obtain some teaching experience during their tenure.

Doctor of Philosophy Degree

Admission to this program is based upon superior work in the usual undergraduate courses in general chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

The Ph.D. candidate will be expected to demonstrate proficiency in reading chemical literature in German and French or Russian. He will also demonstrate to his doctoral committee that he has a broad basic knowledge of the field of chemistry: (1) by completing certain fundamental graduate courses, and (2) by means of a series of examinations in his major field. The principal emphasis of the last two years will be on the research project which will constitute the dissertation. During this time the doctoral candidate will present and defend an original research proposal before his doctoral committee.

Chemical Physics and Soil and Water Chemistry Options

Doctor of Philosophy candidates in Chemistry may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Physics, or the Soil and Water Chemistry program, an interdisciplinary program offered jointly with the Department of Soil and Water Science. In these options, the doctoral student, with the advice of his guidance committee, elects courses in chemistry and in the related disciplines, and writes his dissertation on a research problem appropriate to interdisciplinary treatment.

Master of Science Degree

Admission to this program is based upon a cumulative undergraduate average of 2.5 and requires satisfactory work in the usual undergraduate courses in general chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics. This degree requires the completion of a research problem presented in the form of a thesis.

Master of Science for Teachers Degree

This program is offered for candidates who hold a secondary school teacher certification in chemistry. Courses leading to this degree will normally be chosen from Summer Session and Summer Institute offerings and require 30 semester hours in courses approved by the Department Chairman. Persons interested in this degree should confer with him.

Inorganic Chemistry

775. Inorganic Chemistry

The relationship between chemical reactions and modern concepts of inorganic chemistry on a moderate level. The applicability and limitations of the newer ideas. Mr. Haendler, Mr. Weber. Prerequisite: Chemistry 683-684 or permission of instructor. 3 credits.

804. Advanced Inorganic Chemistry

A survey from the modern point of view, with emphasis on theoretical and structural concepts. Mr. Haendler, Mr. Weber. Prerequisite: Chemistry 775 or its equivalent. 3 credits.

Chemistry

847. Advanced Inorganic Chemistry

The chemistry of coordination compounds, their ligand field spectra, magnetic properties, and reaction mechanisms. The metal-ligand bond in crystal field and molecular orbital theories. Mr. Weber. Prerequisite: Chemistry 804 or permission of instructor. 3 credits.

848. Advanced Inorganic Chemistry

The theory and practice of X-ray diffraction and the determination of crystal structure. Mr. Haendler. Prerequisite: Chemistry 804 or permission of instructor. 3 credits.

Analytical Chemistry

661. Analytical Chemistry

A thorough treatment of the theory and techniques of gravimetric and volumetric analysis followed by special methods of analysis, such as ion exchange and EDTA titrations. Mr. Daggett. Prerequisite: Chemistry 405-406 or equivalent. 3 lectures; 2 laboratories; 5 credits.

762. Instrumental Analysis

A treatment of the theory, instrumentation, and application of methods such as emission spectrography, flame spectrometry, spectrophotometry, gas chromatography, coulometry, potentiometry, conductimetry and polarography to chemical analysis. Mr. Daggett. Prerequisite: Chemistry 661; Chemistry 684 as a prerequisite or concurrently or permission of instructor. 3 lectures; 2 laboratories; 5 credits. Cannot be used for graduate credit by chemistry students.

830. Advanced Optical Methods

Techniques of chemical identification and analysis utilizing optical instrumentation from the standpoint of both theory and application. Topics include NMR, ESR, X-ray fluorescence, mass spectrometry, electron beam microprobe. Mr. Ellis. 3 credits.

831. Advanced Electrical Methods

Techniques of chemical identification and analysis utilizing electrical instrumentation from the standpoint of both theory and application. Topics include controlled-current coulometry, A-C polarography, chronoamperometry, cyclic voltammetry, controlled potential coulometry. Mr. Daggett. 3 credits.

832. Chemical Instrumentation

The basic modules of chemical instrumentation, both electrical and optical. Mr. Ellis. 3 credits.

833. Chemical Separations

The use of various separation techniques prior to analysis, and separations as a method of analysis are discussed. The application of statistics to chemical problems of analysis is covered. Mr. Daggett. 3 credits.

Organic Chemistry**708. Research Techniques**

Lectures and laboratory to show experimental methods and interpretation of results. Topics include gas liquid chromatography, data handling, nuclear magnetic resonance, mass spectrometry, elementary electronics, and X-ray. Staff. 1-3 credits.

755. Advanced Organic Chemistry

An advanced survey of methods of synthesis and determination of structure, including stereochemistry, of complex organic compounds. Structural determination will be based on chemical and spectroscopic properties, emphasis being placed on the solution of assigned problems. The laboratory will be devoted to the synthesis and structural determination of complex organic compounds, techniques for the separation and determination of purity of unknown compounds, and the identification of these unknowns by spectroscopy and chemical means. 3 credits.

756. Characterization of Organic Compounds

The spectroscopic and chemical properties of organic compounds provide a basis of the systematic characterization of organic structures. Methods for the separation of mixtures of organic compounds are considered. Mr. Lyle. Prerequisite: one year of organic chemistry. 1 lecture; 2 laboratories; 3 credits.

801. Theoretical Organic Chemistry

The structural theories of organic chemistry, including valence bond and molecular orbital theories. Emphasis on stereochemistry, including conformational analysis, and aromaticity. 3 credits.

802. Theoretical Organic Chemistry

The mechanistic concepts of organic chemistry, including discussions of theoretical and experimental methods used in the study of reaction mechanisms. 3 credits.

807. Introduction to Research Techniques

A course to introduce the Doctor of Philosophy student to the planning, experimental methods, and interpretation of a research problem. The student will present and defend an original research proposal before a faculty committee. Must be completed satisfactorily by all doctoral students. Cannot be used for credit by Master of Science candidates. Staff. 2 credits.

811. Synthetic Organic Chemistry

Advanced discussion of heterolytic and homolytic substitution and elimination reactions of the major classes of organic compounds, with emphasis on the synthetic utility of these reactions. Permission of instructor. 3 credits.

812. Synthetic Organic Chemistry

Addition, oxidation, and reduction reactions and selected molecular rearrangements, with emphasis on the synthetic applications of these reactions. The synthesis and structure determination of complex organic compounds. Permission of instructor. 3 credits.

Chemistry

817, 818. Special Topics in Organic Chemistry

Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, alkaloids, organic sulfur compounds, and nitrogen heterocycles. Mr. Lyle, Mr. Jones, Mrs. Lyle, Mr. Andersen, Mr. Uebel, and Mr. Morrison. 2 or 3 credits.

Physical Chemistry

663. Introductory Radiochemical Techniques

Radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilize radio-chemical operations. Mr. Amell or Mr. Owens. Prerequisite: general inorganic chemistry and general physics. 2 lectures; 2 laboratories; 5 credits.

683-684. Elementary Physical Chemistry

The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance, and electromotive force. Prerequisite: Mathematics 523 or 426 and physics. Undergraduates must register for Chemistry 685-686 concurrently. 3 credits.

685-686. Physical Chemistry Laboratory

Experimental work illustrating the principles of chemistry. Emphasis is upon the measurement of thermodynamic properties, chemical kinetics, and methods of determining the structure of matter. Prerequisite: Mathematics 523 or 426 and physics. Must be taken concurrently with Chemistry 683-684. 2 laboratories; 2 credits.

776. Advanced Physical Chemistry

Foundations of quantum theory, elementary quantum mechanics, theory of spectra, statistical thermodynamics. Prerequisite: Chemistry 683-684. 4 credits.

805, 806. Advanced Physical Chemistry

Wave mechanics and quantum chemistry, spectroscopy, molecular structure; statistical thermodynamics, kinetics and mechanism. Prerequisite: one year of physical chemistry. 3 credits.

821. Physical Chemistry — Chemical Kinetics

The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to photochemistry. Mr. Amell or Mr. Owens. Prerequisite: one year of physical chemistry. 3 credits.

822. Physical Chemistry — Chemical Thermodynamics

The foundations and interrelationships of the theory of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. Mr. Wheeler. 3 credits.

826. Nuclear and Radiochemistry

Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. Mr. Amell or Mr. Owens. 3 credits.

827, 828. Theoretical Chemistry I, II

The modern concepts and mathematical formalism of quantum mechanics with applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. Mr. Pilar. 3 credits.

829. Theoretical Chemistry III

Statistical mechanics with applications to thermodynamics of non-ideal systems, intermolecular forces, and chemical kinetics. Permission of instructor. Mr. Pilar. 3 credits.

895, 896. Colloquium in Chemistry

a. INORGANIC CHEMISTRY, b. ORGANIC CHEMISTRY, c. THEORETICAL ORGANIC CHEMISTRY, d. PHYSICAL CHEMISTRY, e. ANALYTICAL CHEMISTRY, 3 credits. Sections of the course may be taken to a total of 12 credits.

897, 898. Seminar

Presentation and discussion of recent investigations in chemistry. 1 credit.

899. Thesis — Problems in Chemistry

Conferences, library, and experimental work in some field of chemistry. Staff. Credits to be arranged.

999. Doctoral Research

Courses for the Master of Science for Teachers Degree

The following courses usually are offered only in the Summer Session.

781. The Teaching of High School Chemistry

Contemporary subject matter in general chemistry; choice of experiments for laboratory and lecture demonstrations; and presentation and evaluation of teaching methods which are effective in stimulating students. 4 credits.

782. Modern Inorganic Chemistry for the High School Teacher

The current concepts on such topics as fundamental particles, atomic structure, nuclear reactions, electronic configurations and orbitals, chemical bonds, the periodic table, oxidation-reduction, acids and bases, energy relationships, and ionic reactions. Prerequisite: freshman chemistry. 4 credits.

783. Analytical Chemistry for High School Teachers

The principles of ionic equilibria in qualitative and quantitative analysis. Experimental work in qualitative analysis using the semimicro technique. The experimental work in quantitative analysis acquaints the student with the principles, techniques, and calculations of gravimetric and volumetric determinations. Some experimental work involves the use of the spectrophotometer in quantitative analysis and of the glass electrode method of measurement of pH. 8 credits.

784. Modern Approach to Organic Chemistry for High School Teachers

The structure and properties of organic compounds, including those of current interest and importance, such as natural and synthetic polymers, antibiotics, and medicinals. An understanding of the behavior of organic compounds will

Civil Engineering

be based on the current theories of reactions. Prerequisite: general chemistry. 8 credits.

785. Physical Chemistry for High School Teachers

The laws of chemistry and their application to physical and chemical changes. Prerequisite: college physics, algebra, and trigonometry. 8 credits.

786. Radiochemistry for High School Teachers

The theory of radioactive decay, the effects of radioactive decay upon matter, and the methods and techniques of the detection of radioactive decay. The uses of radiotracers in research. Prerequisite: general chemistry and general physics. 4 credits.

787. Laboratory Techniques in Chemistry

Modern methods for the separation, identification, and estimation of substances. Experiments will be designed to assist the teacher by providing new subjects for laboratory demonstrations and student projects. Prerequisite: analytical and organic chemistry. 4 credits.

788. Advanced Organic Chemistry for High School Teachers

Types of homolytic and heterolytic reactions of organic compounds and their relationship to organic structures, including configuration and conformation. Prerequisite: Chemistry 794 or its equivalent. 4 credits.

789. Atomic and Molecular Structure

The methods of determining atomic and molecular structure, including ultra-violet and infrared spectroscopy and radiochemistry. 4 credits.

Civil Engineering (82)

Chairman: *J. Harold Zoller*

PROFESSOR: J. Harold Zoller

ASSOCIATE PROFESSORS: Harold E. Langley Jr., Tung Ming Wang

ASSISTANT PROFESSOR: Louis H. Klotz

A candidate for the degree of Master of Science in Civil Engineering must have completed a Baccalaureate degree in engineering, mathematics, or science. If his undergraduate work is deficient, he may be required to take undergraduate courses without graduate credit in order to present the proper prerequisites for graduate courses in the areas of his major and minor interests. In addition, other undergraduate courses may be required by his adviser in order to achieve an integrated program. The candidate for the Master's degree will normally complete a thesis for six hours of credit (a maximum of nine hours credit may be awarded in unusual cases). With the permission of the department, a student may be permitted to substitute approved course work for the thesis requirement. In this event he must also submit to his examining committee a paper written in one of his courses which is the equivalent of a thesis in style and quality, but not in scope. One copy of the thesis or paper is required by the department. An oral final examination is required of all candidates.

Courses numbered above 700 may be offered biennially or upon demand.

701. Advanced Surveying

Principles of instrumental and analytical photogrammetry. Theory of conformal mapping and the application to the State Plane Coordinate Systems. Geodetic surveying. Error theory and its application to the planning and adjustment of surveys. Application of electronic computers to surveying calculations. 3 lectures; 1 laboratory; 4 credits.

707. Civil Engineering Materials and Problems in the United States

The origin and distribution of soils and rocks within the continental United States and the influence of these natural materials on the design and construction of engineering works. The comparison of material characteristics and problems as to source and mode of occurrence. 4 lectures; 4 credits.

711. Community Planning

An introduction to Community Planning. Social, economic, and physical factors affecting community planning; content and extent of desirable community-planning programs, including purpose and scope; preliminary survey; elements of land planning; the master plan; transportation and circulation systems; street patterns and traffic; motor vehicle parking; airport sites; public building sites; parks and recreational facilities; zoning; control of land subdivision; neighborhood and shopping centers; housing, legal, financial, and economic problems; and redevelopment of blighted areas. Mr. Dawson. Prerequisite: permission of the instructor. 4 lectures; 4 credits.

714. Contracts, Specifications, and Professional Relations

The essential elements and legal requirements of engineering contracts; the purposes and content of specifications; professional conduct, relations, registration, and ethics. Construction planning and management; cost analysis based on quantity surveys and unit-cost methods. Mr. Dawson. Prerequisite: permission of the instructor. 4 lectures; 4 credits.

721. Highway Engineering

Highway organization, administration, finance, economics, planning, programming, traffic surveys, operations; highway laws, contracts, specifications; highway capacity, geometric design, access control, safety, accident studies; pavement selection, performance, and maintenance. Prerequisite: Civil Engineering 620. 3 lectures; 1 laboratory; 4 credits.

731. Network Planning and Scheduling

The application of Critical Path Methods (CPM) and Project Evaluation Review Technique (PERT) to the design and control of civil engineering projects. 1 lecture; 1 laboratory; 2 credits.

732. Systems Analysis

An analysis of civil engineering projects encompassing social and economic criteria as well as engineering feasibility studies. 1 lecture; 1 laboratory; 2 credits.

744. Sanitary Engineering II

An advanced treatment of water supply and waste water disposal. 4 lectures; 4 credits.

Civil Engineering

745. Hydrology and Hydraulics

The occurrence and physical effects of water on the earth, including meteorology, ground-water runoff, and stream-flow routing, open channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. 4 lectures; 4 credits.

784. Introduction to Matrix and Numerical Methods

Presentation of a unifying concept of basic structural-analysis theories; introduction to matrix and numerical methods of analysis and their application by linear graph concepts using computers. 3 lectures; 1 design period; 4 credits.

790. Inelastic Structural Design

A continuation of modern design theory, ultimate design of reinforced concrete, and plastic analysis of steel structures. 4 lectures; 4 credits.

792-793. Advanced Structural Design I and II

The design in steel by the elastic theory and in reinforced concrete by the working stress method of structural elements and connections, using the appropriate controlling specifications. 3 lectures; 1 design period; 4 credits.

822. Highway and Airport Engineering

Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prerequisite: Civil Engineering 620 and 665. 2 lectures; 2 laboratories; 4 credits.

855-856. Advanced Sanitary Engineering

The application of Chemistry and Microbiology in Sanitary Engineering. The study of control and treatment systems for industrial wastes. 4 lectures; 4 credits.

863-864. Advanced Soil Mechanics I and II

The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. 4 lectures; 4 credits.

865. Soils Engineering

Application of soil mechanics' principles to the selection of the type of sub-structure and the development of its bearing capacity, based on the theories of stability analysis and consolidation. Earth-pressure load determinations by various active and passive earth-pressure theories. Earth dam and foundation construction methods. 4 lectures; 4 credits.

866. Soil Testing for Engineering Purposes

The essential tests for the physical properties: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. 24 credits.

881. Advanced Structural Analysis I

Advanced structural theory and analysis, including multi-story structures, beam columns, frames with variable moment of inertia, continuous trusses and

bents, arches and curved frames, stiff rings, and closed frames. 4 lectures; 4 credits.

882. Advanced Structural Analysis II

Advanced treatment, including flexible and axially loaded flexural members, beams with variable cross-section subjected to axial loads, suspension bridges and flexible arches, and torsional problems of noncircular sections. 4 lectures; 4 credits.

883. Structural Stability

Study of the elastic and inelastic buckling behavior of structures. Topics include: stability of columns, mathematical treatment of buckling problems and buckling criteria, lateral stability of beams, buckling of trusses and framed structures, and stability of rings and curved beams. 4 lectures; 4 credits.

884. Dynamics of Structures

Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one or multi-degrees of freedom. Effects of damping and inelastic action. Vibrations of beams and framed structures. Dynamic response of beams due to moving loads. 4 lectures; 4 credits.

885. Application of System Theory to Structural Analysis

Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 lectures; 4 credits.

886. Facility Project Engineering

A critical review of the approaches to the planning and decision processes of facilities, including: codes and specifications, concepts of engineering economy, index numbers and cost estimation procedures (including an introduction to their statistical basis), mathematical modeling concepts, and the development of design loads and criteria for specific application. 4 lectures; 4 credits.

887. Application of Linear Graphs to Civil Engineering

Concepts of topology and linear graphs and their application to civil engineering planning of transportation, water and sewage distribution, and other networks. Network planning and management systems, including Project Evaluation Review Technique (PERT), Critical Path Methods (CPM), and PERT/cost procedures. 4 lectures; 4 credits.

890. Topics in Structures

Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2-4 credits.

895-896. Civil Engineering Problems

The study and investigations of problems selected to meet the needs of the students. 2-8 credits.

899. Master's Thesis

Hours and credits, 6-9; to be arranged.

Economics

Economics (72)

Dean: *Jan E. Clee*

PROFESSORS: John A. Beckett, John A. Hogan, John J. Korbel, Dwight R. Ladd, Sam Rosen, Kenneth J. Rothwell

ASSOCIATE PROFESSORS: Allan J. Braff, Jan E. Clee, Herman Gadon, James O. Horrigan, Manley R. Irwin, Donald C. Marschner, Robin D. Willits, Dwayne E. Wrightsman

ASSISTANT PROFESSORS: Thomas W. Bolland, Allan R. Cohen, Lawrence P. Cole, William R. Hosek, R. Stephen Jenks, Richard L. Mills, Robert C. Puth, James H. Schulz, John Terninko

Whittemore School of Business and Economics

Admission to graduate study in Economics leading to the degree of Master of Arts is limited to students with a better than average undergraduate record. Candidates for admission are required to take the Graduate Record Examination (both the Aptitude Test and Advanced Test in Economics). The prerequisite for graduate work consists of a minimum of 24 hours of undergraduate study in Economics and related fields of which at least 12 hours shall have been in Economics. In addition, all candidates must either present six hours of undergraduate credit in statistics or mathematics, or take six hours of undergraduate work in statistics or mathematics at the University of New Hampshire without credit, or pass a proficiency test in either field.

The candidate for a Master's degree must fulfill the general requirements of the Graduate School and the following major requirements: (1) Thirty semester hours of graduate study or 24 semester hours and a thesis: (a) a minimum of 21 semester hours in courses numbered 700 and above, of which 6 hours may be satisfied by an acceptable thesis; at least 9 of these hours, exclusive of the thesis, must be in courses numbered 800 and above; (If a thesis is to be submitted, it must be in form for presentation to the Reading Committee by May 1 of the year in which the degree is to be granted.) (b) a maximum of 9 semester hours in approved courses numbered 600 and above in related disciplines. (2) A course grade of P or better at the graduate level as evidence of proficiency in both micro- and macro-economic analysis. (3) Evidence of proficiency, based upon a written examination, in one of the following major areas: (a) Quantitative Methods (b) Labor Economics and Industrial Relations (c) Public Policy Toward Business and Labor (d) Economic Growth and Stability (e) International Economy and Economic Development (f) Resource Development (g) Economic History and the History of Economic Thought.

704. The Economic Development of the U. S. from Colonial Times to the present.

Growth models, quantitative and qualitative evidence on the sources of growth, and the manner in which economic growth influenced and was affected by political and social conditions. Application of economic theory to historical data is stressed. 4 credits.

705. European Economic History

The Economic development of the North Atlantic with emphasis on Britain, France, the Netherlands, and Germany, as well as Italy, Spain, and Russia.

Growth models and analysis of quantitative and qualitative evidence. Comparisons between countries. Effects of urbanization, trade, industrialization, political, and social developments. 4 credits.

727. Public Policy in Social and Labor Legislation

American social and labor legislation of the recent decades and the way in which American economic and human values have been implemented and modified by law. Legislation and private industry programs in social security, reemployment, unemployment insurance, health services, training and retraining, and fair employment practice. Lectures, discussion, assigned reading, and individual student projects. Mr. McConnell. 4 credits. (This course is the same as Sociology 727.)

754. Advanced Money and Banking

Emphasis on central banking, monetary policy, and monetary theory. Study of current problems and developments in banking. Mr. Degler. 4 credits.

758. Imperfect Competition

General description and topics to be covered: Economics 758 will be an extensive survey of firm behavior in noncompetitive or imperfectly competitive market forms such as monopoly, oligopoly, bilateral monopoly, etc. The implications for price and research performance under such market forms will be examined with special consideration given to the problems posed by the interdependent behavior evident in oligopolistic structures. The relevance of the theoretical arguments will be assessed by recourse to appropriate empirical studies. Mr. Hosek. Prerequisite: Economics 673. 4 credits.

774. Mathematical Economics

The principal mathematical techniques and their application in economics. Prerequisite: permission of instructor. 4 credits.

776. Economic Fluctuations

Recurrent movements of prosperity and depression, with emphasis upon causes and public policy implications. Mr. Rosen. Prerequisite: Economics 675 or permission of instructor. 4 credits.

781. Advanced Statistics

The theoretical basis of statistical methods, probability, probability distributions, statistical inference, and decisions. Prerequisite: permission of instructor. 4 credits.

782. Econometrics

The application of statistics and mathematics to economic problems. The formulation of economic models, their measurement and verification. Prerequisite: permission of instructor. 4 credits.

784. Statistical Decision Making

The application of probability and statistics to decision problems. Special emphasis on the Bayesian approach to decisions under uncertainty. Prerequisite: permission of instructor. 4 credits.

Economics

851. Human Relations in Industry

Labor-management relations studied as one aspect of human relations; applications of recent research in the behavioral sciences; case studies. Mr. Hogan. 4 credits.

852. Economics of Collective Bargaining

Tools of economic analysis applied to collective bargaining — wages, productivity, seniority rules, job security, package bargaining. Application to cases. Mr. Hogan. 4 credits.

857-858. History of Economic Thought

The evolution of economic thought. Examination and critical appraisal of the work of major economists and major schools of economists, particularly with reference to the applicability of their theories to current economic problems. Mr. Bowring. 4 credits.

859. Government Regulation of Business

Analysis of government policy with reference to such problems as conspiracy, monopoly, mergers, unfair practices, and discrimination. This analysis includes a legal and economic appraisal of government policy alternatives. Mr. Irwin. 4 credits.

861. National Economic Planning

Analysis of the functioning of various types of national economic systems. Emphasis on economic planning and development. Mr. Donovan. 4 credits.

863. International Economics

Contemporary issues in international economic theory and policy. Analysis of trade theory, balance of payments problems, international liquidity, and the adjustment processes. Mr. Rothwell. 4 credits.

873. Macro-economic Theory

Advanced analysis of such aggregates as national income, total output, employment, and the general price level. Examination of the major aggregate models. Mr. Rosen. 4 credits.

878. Micro-economic Theory

Topics in micro-economics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand theory, and capital theory. Mr. Braff. 4 credits.

891. Seminar in Monetary Theory and Policy

Contemporary developments in monetary theory and the evaluation of policy measures. Mr. Wrightsman. 4 credits.

892. Seminar in Public Finance — Theory and Policy

Selected topics in contemporary theoretical and policy problems of public finance. Mr. Schulz. 4 credits.

894. Seminar in Economic Development

A survey of theories and detailed case studies in problems of economic development. 4 credits.

895-896. Independent Study

Selected projects. Staff. 8 credits.

899. Thesis

Staff. 8 credits.

Education (48)

Chairman: Roland B Kimball

PROFESSORS: Roland B. Kimball, Thomas O. Marshall, Carleton P. Menge

ADJUNCT PROFESSOR: Walter N. Durost

ASSOCIATE PROFESSORS: Angelo V. Boy, John G. Chaltas, David D. Draves, Roselmina Indrisano, Bud B. Khleif, Joseph J. Petroski, Gerald J. Pine, M. Daniel Smith

ASSISTANT PROFESSORS: Michael D. Andrew, Jason E. Boynton, Carl J. Cooper, Albert Elwell, David D. Hebert, Judith Meagher, Philip E. Northway, Philip M. Smith, Deborah E. Stone, W. Dwight Webb

Admission to Graduate Standing

Admission to graduate standing in the Department of Education is granted to applicants meeting the entrance requirements of the Graduate School and accepted by the Department. Applications must include Graduate Record Examination scores for both the aptitude test and the achievement test in the field selected by the applicant.

The Department offers courses leading to the Master of Education degree and to the Master of Arts in Teaching degree.

Master of Education

Master of Education programs are offered in the following areas of specialization:

Elementary Education

Secondary Education

Counseling and Personnel Services

Reading

Administration and Supervision

School Library Science

Applicants should indicate their anticipated area of specialization on their admissions application form.

Specific requirements for completion of the programs vary with the area of specialization. For further information, write to the Chairman, Department of Education.

Thesis or Comprehensive Examination

Candidates in the Master of Education program ordinarily will be expected to complete a research thesis, or a comprehensive examination, which may be written or oral. Each candidate will plan this portion of his program in terms of his own professional needs and in consultation with his graduate adviser. There is no thesis or examination requirement for the Master of Arts in Teaching.

Education

Master of Arts in Teaching

The Master of Arts in Teaching program is designed for candidates who have completed an undergraduate degree with a strong academic major but have not followed a program of professional preparation for teaching. The Master of Arts in Teaching program will provide a balanced curriculum in teacher preparation, with heavy emphasis on a supervised internship in teaching and an opportunity to complete further graduate work in the academic subjects most closely related to the candidate's teaching field.

Candidates will spend two summers and the intervening academic year in graduate study. The first summer will provide an opportunity to study and practice educational methods under the supervision of master teachers in the University's summer high school and summer elementary school. During the academic year the student will be placed in a local school system as a teaching intern with a half-time load. Interns may be paid by the local school system, according to the policy of the local school board. Concurrently the intern will attend seminars on campus which extend his grasp of educational theory and method and will relate these studies to the experiences the intern encounters as a teacher in a school system. The final summer will complete the courses included in the program.

The Master of Arts in Teaching programs are open to prospective elementary school teachers and prospective secondary school teachers of English, mathematics, the sciences, social studies, and foreign languages. For further information prospective elementary school teachers should write to Mr. John Chaltas, Coordinator, M.A.T. Elementary, Department of Education. Prospective secondary school teachers should write to Mr. Philip Smith, Coordinator, M.A.T. Secondary, Department of Education.

Certificate of Advanced Graduate Study

There is a post-master's degree program in counselor education leading to a Certificate of Advanced Graduate Study. Applicants for admission to this program must meet the entrance requirements described on page 19. For further information, write to Professor Angelo V. Boy, Department of Education.

734. Children's Literature

A consideration of children's books and methods of using them, with emphasis given to intermediate grades. Practical demonstrations of how to correlate children's books with various special subjects. 4 credits.

763. Instructional Media

Introduction to instructional media and technology. Emphasis is given to theory, design, and application of instructional media systems. Prerequisite: Education 657. 4 credits.

764. School Library Materials and Services

The background and development of the school library, including functions, objectives, and standards. The relationship of library services to the curriculum, classroom teacher, and students, and to the public library. 4 credits.

765. Reference Materials in the School Library I

The selection and evaluation of basic reference materials common to all libraries. An introduction to school library informational and research techniques. Prerequisite: Education 764. 4 credits.

766. Technical Processes in the School Library I

Ordering, processing, and organizing school library materials. Special emphasis on classification and cataloging systems. Prerequisite: Education 764. 4 credits.

767. Materials Selection for School Libraries

Techniques for building the school library collection in all subjects. Analysis of books for children and young people. Practice in compilation of bibliographies for selected levels and interests. Prerequisite: Education 764 and 766. 4 credits.

785. Educational Tests and Measurements

An introduction to the theory and practice of educational evaluation. Emphasis is given to uses of test results in classroom teaching and student counseling. Introductory statistical techniques. Prerequisite: Education 687. 4 credits.

800. Curriculum and Method in Elementary School Social Studies

An analysis of research studies, current curriculum proposals, and instructional strategies in the field of elementary-school social studies. Prerequisite: Education 611 and teaching experience. 4 credits.

801. Curriculum and Method in Elementary School Mathematics

An analysis of research studies, current curriculum proposals, and instructional strategies in the field of elementary school mathematics. Prerequisite: Education 612 and teaching experience. 4 credits.

802. Curriculum and Method in Elementary School Science

An analysis of research studies, current curriculum proposals, and instructional strategies in the field of elementary-school science. Emphasis will be given to a consideration of contemporary equipment and materials for science education. Prerequisite: Education 613 and teaching experience. 4 credits.

806. Language and Literature in the Elementary School

A study of language and literature in the elementary school including contributions of allied disciplines such as semantics and linguistics. Focus is on the processes of communication and applications to elementary school curriculum. Introduction to bibliotherapy. Prerequisite: Education 616. 4 credits.

807. Survey of Reading

An investigation of the research in reading and reading instruction. Emphasis is on the individual learner, the reading process, and the process of learning to read. Comparison of current diagnostic, developmental, and evaluative methods and materials. Prerequisite: Education 614. 4 credits.

808. Diagnostic and Remedial Reading

Investigations of the nature and causes of reading disability. Study of diagnostic and remedial procedures and materials through case studies, discussions, demonstrations, and practice. Prerequisite: Education 785 and 807. 4 credits.

809. Practicum in Developmental and Remedial Reading and Language

Individual and small group work with children will provide opportunities for clinical analysis, micro-teaching, and evaluation. Seminars will focus on the processes of reading and language and the effects of a variety of methods and

Education

materials on learning. Prerequisite: Education 808 (may be taken concurrently) and permission of instructor at least one month before beginning the course. 4 credits.

810. Reading and Study in the Secondary School

The nature of the reading process, diagnostic and developmental methods and materials, study skills, and reading in the content areas at the secondary school level. Designed for secondary school teachers who wish to foster continuous development of students' reading and study skills. Prerequisite: secondary school teaching experience. 4 credits.

820. Counseling Theory and Practice

The basic approaches to counseling are examined. Consideration is given to their theoretical foundations. Implications for practices in personnel services are emphasized. 4 credits.

821. Psychology of Vocational Development

An investigation of the psychological and informational factors which influence occupational decisions and progress. 4 credits.

822. Psychological Tests in Personnel Services

An analysis of evaluative instruments and techniques which have particular utility in personnel services. Comparisons of sample instruments in terms of psychological or factorial meanings and predictive uses. Prerequisite: Education 718. 4 credits.

823. Group Counseling

An analysis of group dynamics as they apply in group situations relevant to personnel services. Prerequisite: Education 820. 4 credits.

824. Counseling and Guidance in the Elementary School

Principles and procedures of counseling and personnel services for meeting the developmental needs of elementary school pupils. Prerequisite: Education 820. 4 credits.

825. Laboratory in Counseling

Supervised application of counseling through involvement in simulated counseling situations in a laboratory setting. Prerequisite: Education 820. 4 credits.

826. Practicum in Counseling

Supervised experiences in counseling with actual clients in the usual organizational settings. Prerequisite: permission of the instructor. 4 credits.

827. Organization and Administration of Personnel Services

An investigation of the organizational patterns and administrative procedures which influence the effectiveness of personnel services programs. Emphasis is on the elements of productive supervisory and staff relationships. Prerequisite: permission of the instructor. 4 credits.

828. Advanced Counseling Theory and Practice

A detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prerequisite: permission of the instructor. 4 credits.

829. Advanced Practicum in Counseling

Supervised application of advanced counseling theory and practice in actual counseling situations. Samplings of counseling practices will be analyzed and evaluated. Prerequisite: Education 828 and permission of instructor. 4 credits.

830. Research in Personnel Services

A study of research design and methodology in personnel services. Prerequisite: permission of the instructor. 4 credits.

**831. Seminar and Practicum for Master of Arts in Teaching
(Elementary School)**

Observation of reading and elementary mathematics master teachers assigned to the University Summer Elementary School. Opportunities to teach elementary school children under supervision. Related seminars in methods of teaching reading and elementary mathematics. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching Program. 4 credits.

**832. Internship and Seminar for Master of Arts in Teaching
(Elementary School)**

Internship and related seminars as follows: (a) The elementary school curriculum and methods of instruction in elementary school science, social science, music, art, and physical education will be directly related to planning instruction offered by the student as an intern teacher. (b) Half-time elementary school teaching under the supervision of the University faculty. First semester only. Prerequisite: Education 831. 6 credits.

**833. Internship and Seminar for Master of Arts in Teaching
(Elementary School)**

Internship and related seminars as follows: (a) A continuation of the seminar started in Education 832. (b) Internship. Half-time elementary school teaching under the supervision of the University faculty. (Second semester only. Prerequisite: Education 832. 6 credits.

**835. Seminar and Practicum for Master of Arts in Teaching
(Secondary School)**

Practicum and related seminars as follows: (a) The secondary school curriculum and general methods of instruction. Candidates will make a detailed study of the secondary school curriculum and special methods of instruction in their own specific teaching field. (b) Candidates are assigned to a master teacher in their specific teaching field for observation in the University Summer High School. There will be opportunities for candidates to do supervised teaching in their subject field. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching Program. 6 credits.

**836. Internship and Seminar for Master of Arts in Teaching
(Secondary School)**

Internship and related seminars as follows: (a) A continuation of the special methods seminar started in Education 835. Candidates elect the seminar which provides a detailed study of the secondary school curriculum and special methods of instruction in their own specific teaching field. This seminar will be directly related to planning instruction offered by the candidate as an intern

Education

teacher. (b) Half-time secondary school teaching in the candidate's major field under the supervision of the University faculty. (First semester only.) Prerequisite: Education 835. 4 credits.

837. Internship and Seminar for Master of Arts in Teaching (Secondary School)

Half-time secondary school teaching in the candidate's major field under the supervision of the University faculty. (Second semester only.) Prerequisite: Education 836. 4 credits.

838. Sociology of Education: Social Organization of Schools and Community

This course emphasizes viewing schools in their socio-cultural contexts; it is centered on a number of field studies of urban and suburban communities. Among the topics discussed are the following: (a) Comparative institutional analysis — what is church-like, hospital-like, factory-like, and prison-like about the school; (b) relations and perspectives of functionaries and clients in “culturally deprived” and “culturally endowed” settings; and (c) teaching as an emergent profession. 4 credits.

840. Administration of Library-Media Centers

The planning, organizing, and supervising of library-media centers to support the instructional needs of schools. Prerequisite: Education 766 and 767. 4 credits.

841. Reference Materials in the School Library II

Analysis of school-library reference services, materials, and techniques. Prerequisite: Education 765. 4 credits.

842. Technical Processes in the School Library

Ordering, processing, and organizing school library materials. Opportunities for practice in technical management of books, pamphlets, periodicals, tapes, recordings, pictures, and other educational media. Prerequisite: Education 766. 4 credits.

848. Directed Research in School Librarianship

Prerequisite: Education 841 and 842 (may be taken concurrently). 4 credits.

853. Seminar in Curriculum Study

The techniques and procedures of curriculum development and strategies for curriculum change in the public schools. Prerequisite: teaching experience. 4 credits.

858. Analysis of Teaching

A comparative analysis of current techniques and instrumentation for studying the process of teaching in the classroom. Consideration of substantive and procedural issues involved in planning for teaching. Prerequisite: teaching experience. 4 credits.

861. Public School Administration

An introductory course examining major issues in policy-making, school management, personnel, public relations, finance, and research in school administration. Prerequisite: teaching experience. 4 credits.

862. Educational Finance and Business Management

Principles of financing education, budgetary procedures, accounting, auditing, school indebtedness, financial reporting and business management. Experience in handling practical school finance problems will be part of the project work. Prerequisite: Education 861. 4 credits.

863. Seminar in Educational Administration

Cases and concepts in educational administration. Prerequisite: Education 861. 4 credits.

865. Educational Supervision

Theoretical foundations of supervisory behavior as a means of effecting changes in instructional practices; consideration of instruments and techniques based on those theoretical foundations; some opportunity for field projects utilizing instruments and techniques. Prerequisite: teaching experience. 4 credits.

867. Legal Aspects of School Administration

Legal aspects of school administration, emphasizing federal and state laws which establish the duties, privileges, and responsibilities of school board members, superintendents, principals, and teachers. The legal aspects of school district organization, negotiation procedures and personnel policies, fiscal operations, school building construction, compulsory attendance, pupil transportation services, and the current legal issues involved in state and federal aid to education. Prerequisite: Education 861 and 863. 4 credits.

869. Practicum in Educational Administration

Supervised practical experience in dealing with problems in educational administration. Prerequisite: Education 863. 4 credits.

881. Methods and Techniques of Educational Research

Quantitative methods employed in the investigation of educational problems. Prerequisite: Education 785 and permission of instructor. 4 credits.

883. Advanced Psychology of Human Learning

Special topics in the field of educational psychology with emphasis on the learning process: (a) examination of learning situations in the classroom in the light of experimental research; (b) examination and evaluation of learning situations in the light of the major theories of learning. Prerequisite: Education 657. 4 credits.

884. Advanced Human Development

A personal exploration of the social, psychological, and educational aspects of human development. Special emphasis on emotional growth through school practices in human encounter. Prerequisite: Education 481. 4 credits.

886. Philosophy of Education

A comparative analysis of contemporary educational objectives and practices and the philosophical foundations upon which they are based. Prerequisite: Education 657 and 659. 4 credits.

Electrical Engineering

888. Sociology of Education: The Cultures of Poverty and Affluence

The two cultures are treated as a unit; culture change is discussed. Issues of current interest are explored, e.g., poverty, school desegregation, the schooling of geographically-mobile children, problems of social mobility and abundance, the rise of the counseling and healing trades, and teachers' quest for professionalism. The education of "culturally deprived" and "culturally endowed" children receives special attention. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. Prerequisite: Education 659. 4 credits.

895. Independent Study in Education

An opportunity for intensive investigation of a special problem or issue in the field of education. Permission of instructor is required. 2-4 credits per semester. May be repeated to a maximum of 8 credits.

897. Seminar in Contemporary Educational Problems

A seminar offered by one or more members of the staff dealing with issues or problems of special contemporary significance. Normally the seminar will focus on a problem which has been the subject of recent special study by the staff member(s). Prerequisite: permission of the instructor(s). 4 credits. May be repeated for different topics.

899. Thesis

Prerequisite: permission of the department. 4-8 credits

Electrical Engineering (83)

Chairman: *Joseph B. Murdoch*

PROFESSORS: Fletcher A. Blanchard, Albert D. Frost, Joseph B. Murdoch, Alden L. Winn

ASSOCIATE PROFESSORS: Ronald R. Clark, Donald W. Melvin, Henry R. Skutt, Kerwin C. Stotz

ASSISTANT PROFESSORS: Glen C. Gerhard, Filson H. Glanz, John L. Pokoski, Edward P. Sayre, Harold F. Wochholz

To be admitted to graduate study in Electrical Engineering a student should have completed work in his major field equivalent to that currently required of undergraduates at the University of New Hampshire.

A minimum of 30 credits is required for the Master of Science degree in Electrical Engineering. All students are required to complete two basic courses, Electrical Engineering 801 and 811, at the beginning of their program, or furnish evidence of equivalent preparation. Students are further required to demonstrate the ability to do independent and creative work by taking either Electrical Engineering 899 or 891-892. With the consent of the Graduate Committee, a student who has satisfied this requirement through industrial experience may substitute approved course work.

Electrical Engineering 899 and 891-892 both involve equivalent independent theoretical and/or applied work under the guidance of a faculty member. The sequence 891-892 is to be completed in two consecutive semesters, with a letter grade given at the end of each semester. An interim report is submitted at the end

of 891 and a final (oral and written) report at the end of 892. Electrical Engineering 899 requirements include the submission of a formal thesis suitable for binding. However, no two-semester time-limit is imposed, and no interim or final letter grade is given. Those who intend to undertake graduate work in Electrical Engineering must consult with the department graduate adviser in order to plan their program of study.

Permission of the instructor is required for enrollment in all Electrical Engineering graduate courses.

706. Advanced Circuit Theory

Steady-state and transient analysis, derivation of fundamental formulas and constants, application of Laplace transforms. 4 credits.

711. Digital Systems

Generalized, systematic and practical approach to the logical design of digital systems encompassing circuit components, binary arithmetic, Boolean algebra, simplification methods and derivation of application and input equations. Practical combinational circuits and logical arrays are emphasized in both synchronous and asynchronous applications. Logical equivalents are formulated together with the system aspects of interfacing digital communication systems, wiring and reliability considerations. Prerequisite: senior status or above within the College of Technology or approval of the instructor. 3 recitations; 1 laboratory; 4 credits.

712. Logical Design of Digital Computers

Extension of EE 711 to the design of both general and special purpose digital computers. The design parameters of input-output, memory, peripheral, arithmetic, and control units are established together with complete design equations for representative digital computers. Analog and hybrid methods are presented together with error-free techniques and a survey of research trends applicable to present and next generation computers. Prerequisite: Electrical Engineering 711 or approval of instructor. 3 recitations; 1 laboratory; 4 credits.

725. Advanced Analysis of Machinery

Steady-state and transient analysis of alternating and direct-current machines. Prerequisite: Electrical Engineering 520. 3 recitations; 1 laboratory or conference; 4 credits.

727. Power Systems

An introduction to the steady-state and transient analysis of large, electrical power systems. Prerequisite: Electrical Engineering 520. 3 recitations; 1 laboratory or conference; 4 credits.

741. Fundamentals of Acoustics

The development of the acoustical wave equation for gases, solids, and liquids; reflection, refraction, and absorption; characteristics of acoustic sources; directivity of multi-source arrays; acoustical measurements and architectural acoustics; airborne noise control. Prerequisite: Physics 502 and Mathematics 527. 4 credits.

757. Communication Theory

Introduction to information theory; Fourier analysis, continuous and pulsed modulation; sampling, quantization; noise in electrical circuits. 4 credits.

Electrical Engineering

758. Communication Systems

Application of communication theory and electronics to high frequency communication system design. Modulators, R. F. amplification, receivers, antennas, free space propagation, ionospheric properties. Prerequisite: Electrical Engineering 509, 757, or equivalent. 3 recitations; 1 laboratory; 4 credits.

762. Illumination

Radiation, fundamental processes in gases, atomic spectra, sources of visible and near visible energy, lamp circuitry, illumination design, control of light, photometry, and color. 2 or 4 credits.

780. Engineering Analysis

The basic principles and analytical methods employed in the solution of complex interdisciplinary engineering problems. Prerequisite: permission of instructor. 4 credits.

781. Instrumentation

Analysis and design of equipment for measurement, instrumentation, and control. 3 recitations; 1 laboratory; 4 credits.

782. Control Systems

Fundamental principles involved in the design and analysis of feedback control systems. 3 recitations; 1 laboratory; 4 credits.

796. Special Topics in Electrical Engineering

New or specialized courses are presented under this listing, on sufficient demand. Independent study can be given under this course title. Prerequisite: permission of instructor. 2 or 4 credits.

801. Field Theory

The application of Maxwell's Equations to static and dynamic field problems. Introduction to the general wave equation in rectangular, cylindrical, and spherical coordinate systems. 3 credits.

802. Electromagnetic Wave Theory

Advanced topics in electromagnetic field theory including waves in non-isotropic media and antenna characteristics. Prerequisite: Electrical Engineering 801. 3 credits.

803. Principles of Microwave Systems

Wave propagation in free space; dielectrics and conductors; normal modes of waveguides and cavities; interactions between traveling waves and electrons; generation at high frequencies. Prerequisite: Electrical Engineering 801. 3 credits.

804. Antennas

Theory and design of electromagnetic radiating systems. Prerequisite: Electrical Engineering 801. 3 credits.

811. Fundamentals of Signal Processing

Introductory probability theory, matrices and determinants, introductory graph theory. Laplace transforms and pole-zero concepts, complex-variable theory, convolution theorems. 3 credits.

812. Network Synthesis

Passive network synthesis techniques. Analysis and synthesis of integrated and thin-film structures. Active network synthesis methods. Prerequisite: Electrical Engineering 811. 3 credits.

813. Nonlinear Networks

Analysis of passive networks with non-linear and time-varying parameters. 3 credits.

814. Network Approximation

Network design through approximation in the time and frequency domains. Prerequisite: Electrical Engineering 812. 3 credits.

815. Linear Active Circuits

Development of equivalent circuits for solid-state devices; analysis and design of linear networks containing these devices. 3 credits.

816. Nonlinear Active Circuits

Analytical and graphical techniques for circuits designed for pulse and other non-sinusoidal signals; and solid-state or vacuum-tube devices used in the switching mode. 3 credits.

817. Network Analysis

Topological properties and analysis of networks; one to n-port networks; natural frequencies; eigen values, and state variables; parts of network functions; Fourier and Hilbert transforms; time-and-frequency domain correlation. Prerequisite: Electrical Engineering 811. 3 credits.

821. Transmission and Distribution of Electric Power

Line characteristics, steady-state performance, symmetrical compounds, lightning over-current protection, relaying. 3 recitations; 1 laboratory or conference; 4 credits.

831. Semiconductor Electronics

A study of topics in solid-state electronics including semiconductor physics, theory of semiconductor devices, bulk effects, semiconductor technology, and selected applications. Prerequisite: Electrical Engineering 505. 3 credits.

839. Statistical Theory of Communications

Harmonic analyses of periodic, aperiodic, and random functions. Probability, correlation, power density spectra, sampling theory, detection of periodic signals in noise, and optimum filtering. 3 credits.

840. Information Theory

Discrete and continuous probability, fundamentals of encoding, basic information theory, and stochastic processes. 3 credits.

851. Advanced Control Systems I

Advanced topics in analysis and design of linear and non-linear, feedback control systems. Prerequisite: Electrical Engineering 782. 3 credits.

English

852. Advanced Control Systems II

Special topics in control theory; such as multivariate, optimal, adaptive, and other state-of-the-art control topics. Prerequisite: Electrical Engineering 851. 3 credits.

856. Switching Theory

Combinational circuits — including functional decomposition, non-binary logic, and cellular networks. Sequential networks — including analysis, transient behavior, state reduction methods, state assignment, and synthesis. Prerequisite: Electrical Engineering 711. 3 credits.

891-892. Research

3 credits each semester.

898. Independent Study

Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1-3 credits per semester.

899. Master's Thesis

6 credits.

English (49)

Chairman: *John C. Richardson*

PROFESSORS: Sylvester H. Bingham, G. Harris Daggett, William B. Hunter, Donald M. Murray, Dale S. Underwood, Thomas Williams

ASSOCIATE PROFESSORS: Lewis C. Goffe, Robert D. Hapgood, Max S. Maynard, Edmund G. Miller, Philip L. Nicoloff, John C. Richardson, John A. Yount

ASSISTANT PROFESSORS: Thomas A. Carnicelli, Terrence P. Logan, Hugh M. Potter

The Department of English offers two advanced degrees, the Master of Arts and the Master of Science for Teachers. The Master of Science for Teachers is a terminal degree, one designed for the high school teacher. The Master of Arts is, primarily, the first step to the doctoral degree; the candidate will ordinarily be preparing for teaching in a college or university.

For the Master of Arts degree, a reading knowledge of French, German, Italian, or Latin is required of the candidate. For the Master of Science for Teachers degree, no foreign language is required.

The student who is a candidate for the degree of Master of Science for Teachers must complete 30 credits in English numbered above 700 that will not be a repetition of his undergraduate course work.

The student who is a candidate for the Master of Arts degree must take 7 courses, no more than 2 in courses numbered 712-799; at least 5 in courses numbered 812-898 (2 of which must be graduate seminars: 885-898); and write a thesis (899).

A student taking a course numbered 812-884, though attending the undergraduate lectures, must do additional work assigned by his instructor and prepare a paper on an agreed subject connected with his study.

All graduate students, even though they attend undergraduate classes, are marked on the graduate level.

The complete first draft of the thesis must be submitted to the thesis director at least two months before the degree is to be granted. The final copies must be ready for signing by the thesis director and two other readers at least three weeks before the degree is to be granted.

701-702. Advanced Writing of Fiction and Poetry

Workshop discussions of advanced writing problems, and readings of students' fiction, poetry, or plays. Individual conferences. Mr. Williams. Written permission of instructor required for registration. 4 credits.

703-704. Advanced Non-Fiction Writing

A workshop course for advanced students of writing, with discussions and individual conferences. Mr. Murray. Written permission of instructor required for registration. 4 credits.

705. English Grammar

A review of English grammar including both traditional and contemporary approaches. Mr. Goffe. 4 credits.

706. English Linguistics

A descriptive approach to modern English grammar, emphasizing the insights provided by linguistic analysis. Mr. Hunter. 4 credits.

709, 710. Critical Analysis of Exposition and Fiction

709, Exposition; 710, Fiction. Mr. Bingham. 4 credits.

711. Critical Analysis of Poetry and Drama

A non-historical, non-genre approach to individual poems and plays with emphasis on the works themselves. Mr. Richardson. 4 credits.

713, 714. Literary Criticism

Major critics from Plato to the present and the chief critical approaches to literature. Mr. Hapgood. 4 credits.

742. Puritanism and the Enlightenment in America

American literature and thought from the Colonial beginnings through the early republic. 4 credits. (Not offered in 1969-70.)

743. American Transcendentalists

Emerson, Thoreau, and other transcendentalists. (Formerly English 775.) 4 credits. (Not offered in 1969-70.)

744. American Fiction to the Civil War

Cooper, Poe, Hawthorne, Melville, and others. (Formerly English 776.) Mr. Goffe. 4 credits.

745. American Poetry of the Nineteenth Century

Bryant, Poe, Emerson, Whitman, Dickinson, and others. (Formerly English 777.) Mr. Daggett. 4 credits.

English

746. American Realism and Naturalism

Twain, Henry James, Adams, Stephen Crane, Dreiser, and others. Mr. Potter. 4 credits.

747, 748. American Fiction and Drama of the Twentieth Century

Fitzgerald, Hemingway, O'Neill, Faulkner, and others. (Formerly English 779, 780.) Mr. Nicoloff and Mr. Potter. 4 credits.

749. American Poetry of the Twentieth Century

Robinson, Frost, Stevens, Pound, Eliot, Jeffers, Hart Crane, Robert Lowell, and others. Mr. Nicoloff. 4 credits.

751. History of the English Language

A study of the evolution of the English language, with special emphasis upon the relation between linguistic change and literary style. Mr. Carnicelli. 4 credits.

753. Old English

An introduction to Old English language and literature through readings of selected poetry and prose. Mr. Carnicelli. 4 credits.

754. *Beowulf*

A reading of the poem and an introduction to the scholarship. Mr. Carnicelli. Prerequisite: English 753. 4 credits.

755, 756. Chaucer

755: Chaucer's allegorical poems and *Troilus and Criseyde*.

756: *The Canterbury Tales*. Mr. Underwood. 4 credits.

757, 758. Shakespeare

The major plays of Shakespeare. 757 surveys a number of representative plays; 758 studies a few plays more intensively. 757 is prerequisite to 758. Mr. Hapgood, Mr. Hunter, Mr. Logan. 4 credits.

759. Milton

Milton's life and times, all his poetry, and a selection of his prose. 4 credits. (Not offered in 1969-70.)

763, 764. English Literature in the Sixteenth Century

763: Major literary figures of the continental Renaissance (in translation), including Petrarch, Machiavelli, Ariosto, Rabelais, Montaigne, Cervantes, and Erasmus; major English writers of the period, including More, Skelton, Wyatt, and Surrey. 764: Sidney, Drayton, and other late Elizabethans, with emphasis upon Spenser. Mr. Logan. 4 credits.

765, 766. English Literature in the Seventeenth Century

765: Major writers of prose and poetry in the first half of the century; special emphasis upon the relationships between the metaphysical and the classical modes of poetry. 766: Restoration comedy of manners, heroic drama, verse satire, Dryden, Milton, and Bunyan. (Not offered in 1969-70.) 4 credits.

767, 768. English Literature in the Eighteenth Century

767: Addison, Steele, Defoe, Pope, and Swift. 768: Gray, Collins, the Wartons, Burke, Goldsmith, Reynolds, Johnson, Boswell, Crabbe, Burns, and Blake. Mr. Maynard. 4 credits.

769. The English Romantic Period

Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey, Byron, Shelley, and Keats.
Mr. Miller. 4 credits.

771, 772. Victorian Prose and Poetry

771: Carlyle, Mill, Ruskin, Newman, Tennyson, and Browning. 772: Arnold, Clough, the Pre-Raphaelites, Swinburne, Hardy, Housman, and others. 4 credits.
(Not offered in 1969-70.)

773, 774. British Literature of the Twentieth Century

773: Shaw, Conrad, Joyce, Yeats, and others. 774: Huxley, Lawrence, Eliot, Auden, Dylan Thomas, and others. Mr. Daggett and Mr. Richardson. 4 credits.

781, 782. Introduction to English Drama

The development of English drama, exclusive of Shakespeare, from the Middle Ages to the present. 781: From the Middle Ages to the closing of the theatres in 1642. 782: From the Restoration to the present. Mr. Caldwell. 4 credits.

783. The English Novel of the Eighteenth Century

Mr. Bingham. 4 credits.

784. The English Novel of the Nineteenth Century

One representative novel of each of the following: Jane Austen, Scott, Dickens, Thackeray, Emily Bronte, Charlotte Bronte, Trollope, George Eliot, and Hardy.
Mr. Miller. 4 credits.

791. (English Education) Problems in the Teaching of High School English

Principles and methods of teaching literature, composition, and language in secondary schools. Mr. Goffe. Prerequisite: a grade of C or better in Education 758. 4 credits.

797, 798. Special Studies in Literature

The precise topics and methods of each section will vary.

- | | |
|--------------------------------|--------------------------|
| 1. Old English Literature | 8. The Twentieth Century |
| 2. Medieval Literature | 9. The Drama |
| 3. The Renaissance | 10. The Novel |
| 4. The Seventeenth Century | 11. Poetry |
| 5. The Eighteenth Century | 12. Non-fiction |
| 6. The English Romantic Period | 13. American Literature |
| 7. The Victorian Period | 14. A Literary Problem |
- Professorial staff. 4 credits.

813, 814. Literary Criticism

4 credits.

842. Puritanism and the Enlightenment in America

4 credits. (Not offered in 1969-70.)

843. American Transcendentalists

4 credits. (Not offered in 1969-70.)

English

844. American Fiction to the Civil War
4 credits.
845. American Poetry of the Nineteenth Century
4 credits.
846. American Realism and Naturalism
4 credits.
- 847, 848. American Fiction and Drama of the Twentieth Century
4 credits.
849. American Poetry of the Twentieth Century
4 credits.
851. History of the English Language
4 credits.
853. Old English
4 credits.
854. *Beowulf*
4 credits.
- 855, 856. Chaucer
4 credits.
- 857, 858. Shakespeare
4 credits.
859. Milton
4 credits. (Not offered in 1969-70.)
- 863, 864. English Literature in the Sixteenth Century
4 credits.
- 865, 866. English Literature in the Seventeenth Century
4 credits. (Not offered in 1969-70.)
- 867, 868. English Literature in the Eighteenth Century
4 credits.
869. The English Romantic Period
4 credits.
- 871, 872. Victorian Prose and Poetry
4 credits. (Not offered in 1969-70.)
- 873, 874. British Literature of the Twentieth Century
4 credits.
- 881, 882. Introduction to English Drama
4 credits.

883. The English Novel of the Eighteenth Century
4 credits.
884. The English Novel of the Nineteenth Century
4 credits.
- 885, 886. Seminar — Problems in Medieval Literature
Mr. Underwood. 4 credits.
887. Seminar — Studies in Sixteenth-Century Literature
Mr. Logan. 4 credits.
888. Seminar — Problems in Milton Scholarship and Criticism
Mr. Hunter. 4 credits.
889. Seminar — Studies in Shakespeare
4 credits. (Not offered in 1969-70.)
890. Seminar — Studies in English Drama
4 credits. (Not offered in 1969-70.)
891. Seminar — Studies in American Literature of the Nineteenth Century
Mr. Nicoloff. 4 credits.
892. Seminar — Studies in Restoration Literature
4 credits. (Not offered in 1969-70.)
893. Seminar — Studies in Early Seventeenth-Century Literature
Mr. Hunter. 4 credits.
899. Master's Thesis
6 credits.
-

Entomology (29)

Chairman: *James G. Conklin*

PROFESSORS: Robert L. Blickle, James G. Conklin

ASSISTANT PROFESSOR: R. Marcel Reeves

For admission to graduate study in Entomology an applicant is expected to have had adequate preparation in undergraduate Entomology and related sciences. Students lacking the necessary background courses may be required to complete certain courses which do not carry graduate credit before they are admitted to candidacy for a degree.

The program of graduate study is designed to meet the needs of those students who are planning to take further work leading to a career in professional entomology.

A thesis is required of all candidates for the Master's degree.

Forest Resources

704. Medical Entomology

Insects and arachnids in relation to public health. The more important disease carriers, their biologies, and means of control. Adapted especially for students who are interested in public health or medicine. Elective for juniors and seniors. Mr. Blickle. 2 lectures; 1 laboratory; 4 credits.

707-708. Advanced Entomology

The anatomy and physiology of insects. Aquatic and systematic entomology. Mr. Conklin and Mr. Blickle. Open to others than Entomology majors by permission of Department Chairman. 2 lectures; 1 laboratory; 4 credits.

709-710. Advanced Economic Entomology

Problems in applied Entomology; the literature of economic entomology. Investigational methods. Studies of the specialized phases of entomology. Mr. Conklin and Mr. Blickle. Required of Entomology majors. Open to others than Entomology majors by permission of Department Chairman. 2-4 credits.

801, 802. Graduate Entomology

Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Mr. Conklin and Mr. Blickle. Subject matter, hours, and credits to be arranged.

899, (899). Graduate Entomology. Master's Thesis

Mr. Conklin, Mr. Blickle, and Mr. Reeves. Hours and credits to be arranged. 6-10 credits.

Forest Resources (30)

Chairman: *Otis F. Hall*

PROFESSORS: Paul E. Bruns, Otis F. Hall

ASSOCIATE PROFESSORS: James P. Barrett, John L. Hill, Harold W. Hocker Jr., David P. Olson, Oliver P. Wallace

ASSISTANT PROFESSORS: Bennett B. Foster, R. Marcel Reeves, Roger P. Sloan, Richard R. Weyrick

Students admitted to graduate study in Forestry are expected to have completed a course of study equivalent to that required for the degree of Bachelor of Science in Forestry. Those lacking this training may be admitted to candidacy after completing certain courses without graduate credit. Candidates for the Master's of Science in Forestry Degree must pass an oral examination. A thesis may not be required.

Graduate study leading to the Master of Science, major in Wildlife Management, is available in either the Department of Forest Resources or through a cooperative program with the Department of Animal Sciences.

702. Natural Resources Policy

Contemporary issues in the management and allocation of natural resources. The impact of human activity and demands on resources, including agricultural and forest lands, water, wildlife, fisheries, and minerals. Historical perspective as it contributes to an understanding of current public and private resource

policies. Mr. Bruns, Mr. Weyrick, Mr. Bowring, Mr. Drew. Prerequisite: permission of instructor. 4 credits.

711. Statistical Methods II

An intermediate course in statistics. Topics include basic concepts of sampling, linear models and analyses for one-way and multi-way classifications, factorial arrangement of treatments; multiple regression, and covariance. Mr. Barrett. Prerequisite: Forest Resources 528 or equivalent. 4 credits.

712. Sampling Techniques

A study of the techniques of sampling a finite population. Topics include choice of sampling unit and frame, estimation of sample size, confidence limits, and comparisons of sample designs. Mr. Barrett. Prerequisite: Forest Resources 528 or equivalent. 4 credits.

730. Forest Tree Improvement

The genetics of forest tree improvement with emphasis on variation in natural populations, the basis for selection of desired characters, and the fundamentals of controlled breeding. The application of principles will be directed toward silviculture, management and utilization. Mr. Hocker. Prerequisite: permission of instructor. (Alternate years; offered in 1969-70.) 3 lectures; 1 laboratory; 4 credits.

734. Forest Fish and Game

Fish and wildlife population dynamics and the theory of game-management. The characteristics of important game species and management techniques useful in the northeastern forest habitat. Elective with permission of instructor. Mr. Olson. 3 lectures; 1 laboratory; 4 credits.

746. Forest Resources Seminar

Case studies of forest land units. Population trends and human needs in relation to forest land productivity for timber, wildlife, water, recreation, and grazing. Organized groups involved in forest land-use and management, and overall planning to help maximize forest land-use and productivity for our society will be studied. Mr. Wallace. Prerequisite: Forest Resources 661. 4 credits.

755, 756. Forest Wildlife Management

Readings and discussions on the properties of wildlife species and the various phases of management, including public relations, law enforcement, and control of undesirable species. Students should be prepared to participate in weekend field trips to game management areas in New England. Mr. Olson. Prerequisite: Forest Resources 734 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

758. Photogrammetry in Forestry

Elementary principles of photogrammetry with emphasis on their application to all phases of forestry. The value and use of aerial photos in forest typing, planimetric, and topographic mapping; measurement of area and volume estimation. Mr. Bruns, Mr. Barrett. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

Forest Resources

763. Forest Recreation Seminar

The recreational use of forest lands including factors that affect demand and supply for recreation. Planning for state and local recreational use, emphasizing the economic and social aspects. Mr. Wallace. Prerequisite: junior standing and permission of instructor. 4 credits.

764. Forest Industry Economics

Application of business methods and economics in the establishment and operation of forest industries; planning for minimum-cost operation and the profitable use of capital in forest enterprises. Mr. Wallace. Prerequisite: senior standing and permission of instructor. 3 lectures; 1 laboratory; 4 credits.

801, 802. Forest Management Seminar

Seminar discussions of current literature, plans, and principles and new developments in the general field of forest management. Mr. Bruns and members of the department. Prerequisite: permission of instructor. 2 credits.

803. Approach to Research

The meaning of science and the scientific method. The application of logic in the scientific method. The general principles and techniques of scientific research. A general survey of statistical procedures as a tool for research. The organization of investigative work including problem analyses, working plans, and the preparation of reports. Mr. Foster and members of the department. Prerequisite: permission of instructor. 2 credits.

805. Utilization Seminar

Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Mr. Hill. Prerequisite: permission of instructor. 2-hour seminar; 2 credits.

806. Logging Economics Seminar

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of raw material procurement. Mr. Foster. Prerequisite: permission of instructor. 2-hour seminar; 2 credits.

809, 810. Wildlife Management Seminar

Discussions and assigned reports on current investigations and developments in wildlife management. Mr. Olson. Prerequisite: undergraduate courses in wildlife management. 2-hour seminar; 2 credits.

815. Advanced Mensuration

Volume-table construction and application, advanced studies of growth and yield, and methods of prediction. Application of graphic and statistical solutions to these problems. Mr. Barrett. Prerequisite: permission of instructor. 2 lectures; 1 laboratory; 3 credits.

818. Advanced Photogrammetry in Forestry

The application of aerial photogrammetrical techniques to specific forestry problems. The use of photographs for volume estimation including cull, volume tables, and species composition; use in fire control, range, timber and recre-

ational management, road location, allocation of cut, and design of large-scale resource inventories. Mr. Bruns and Mr. Barrett. Prerequisite: permission of instructor. 2 credits.

833. Forest Protection Seminar

Discussion and special problems based on principles and techniques of forest protection. Mr. Weyrick. Prerequisite: Forest Resource 660 or equivalent. 3 credits.

861, 862. Investigations in (1) Forest Ecology, (2) Photogrammetry, (3) Wood Utilization, (4) Game Management, (5) Mensuration, (6) Forest Economics, (7) Forest Management, (8) Logging Economics

Work to be arranged according to the needs of individual students. Staff. Hours to be arranged. Prerequisite: permission of instructor. 2-4 credits.

899. Thesis

Hours and credits to be arranged to meet the needs of the individual student. Prerequisite: graduate standing and permission of instructor in the selected field of study. 6-10 credits.

French and Italian

Chairman: *Samuel E. Stokes, Jr.*

PROFESSOR: Louis J. Hudon

ASSOCIATE PROFESSOR: Samuel E. Stokes Jr.

VISITING ASSOCIATE: Edna S. Hudon

ASSISTANT PROFESSORS: Grover E. Marshall, Margaret J. Sullivan

The Department of French and Italian offers courses leading to two degrees, Master of Arts and Master of Science for Teachers in French.

To be admitted to graduate study for the Master of Arts degree, a student must have completed an undergraduate major in French or the equivalent thereof. He must also submit scores of the Graduate Record Examination, both the Aptitude Test and the Advanced Test in French.

To satisfy requirements for the Master of Arts degree, the student must complete 8 courses and write a Master's thesis. Six of the courses must be in French, four among French courses numbered 800 or above. Two of the eight courses may be taken in related departments. The thesis must embody results of independent investigation and be written in a form acceptable to the Department. It must be submitted to the thesis director before April 20 of the academic year in which the degree is to be granted. To be admitted to graduate study for the Master of Science for Teachers degree in French, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in that language.

To satisfy course requirements for the Master of Science for Teachers degree, the student must complete 10 courses. Six must be in French, four from French courses numbered 800 or above; two of the courses may be taken in related departments; and two may be transferred from an accredited NDEA institute, offering graduate courses.

French and Italian

The candidate for the Master of Science for Teachers degree must pass a departmental oral and written examination on or before April 20 of the academic year in which the degree is to be granted.

All courses in the Department are conducted in French.

French (56)

741. French Literature of the Middle Ages

Readings in the epic, lyric poetry, and the romance. Prerequisite: French 606. 4 credits. (Alternate years; not offered in 1969-70.)

742. French Literature of the Renaissance

Readings in the literature of the sixteenth century. Prerequisite: French 606. 4 credits. (Alternate years; not offered in 1969-70.)

759-760. French Literature of the Seventeenth Century

Readings in the literature of the seventeenth century. Prerequisite: French 606. 4 credits. (Alternate years; offered in 1969-70.)

761-762. Eighteenth Century French Literature and Thought

Readings in the Age of Enlightenment and *belles lettres* of the period. Prerequisite: French 606. 4 credits. (Alternate years; not offered in 1969-70.)

767-768. Nineteenth Century French Literature

Readings in Romantic, Parnassian, and Realistic literature of the century. Prerequisite: French 606. 4 credits. (Alternate years; offered in 1969-70.)

(770). Introduction to Modern French Poetry

Studies in French Poetry from Baudelaire to the present. Prerequisite: French 606. 4 credits. (Alternate years; offered in 1969-70.)

781-782. Contemporary French Novel and Theater

Readings in the French novel and theater of the twentieth century. Prerequisite: French 606. 4 credits. (Alternate years; not offered in 1969-70.)

788. Seminar in French Literature

A study of French authors chosen by the instructor. Prerequisite: French 606. 4 credits. (Alternate years; offered in 1969-70.)

790. Advanced Language and Style

Translation of literary texts, intensive study of the principal techniques of style, *explication de textes*. Open to qualified students who have had a minimum of two courses in French numbered 741 and above. 4 credits.

795, 796. Special Studies in French Language and Literature

Individual, guided study in special topics, with training in bibliography and organization of material. Examples of topics which may be selected are: the work of a major French author, specific topics in any area of French literature, such as literary criticism in a given period. Prerequisite: permission of the department chairman. 4 credits.

841. French Literature of the Middle Ages

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1969-70.)

842. French Literature of the Renaissance

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1969-70.)

859-860. French Literature of the Seventeenth Century

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1969-70.)

861-862. Eighteenth Century French Literature and Thought

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1969-70.)

867-868. Nineteenth Century French Literature

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1969-70.)

(870). Introduction to Modern French Poetry

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1969-70.)

881-882. Contemporary French Novel and Theater

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1969-70.)

888. Seminar in French Literature

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1969-70.)

890. Advanced Language and Style

Prerequisite: Open to qualified students who have had a minimum of two courses in French numbered 741 and above. 3 credits.

895, 896. Special Studies in French Language and Literature

Prerequisite: permission of the department chairman. 3 credits.

899. Master's Thesis

6 credits.

Genetics Program (97)

Chairman: *D. MacDonald Green*

PROFESSORS: Walter M. Collins, Gerald M. Dunn, D. MacDonald Green, Lincoln C. Peirce, Richard W. Schreiber

ADJUNCT PROFESSOR: Ernst J. Schreiner

ASSOCIATE PROFESSORS: Frank K. Hoornbeck, James P. Barrett, Harold W. Hocker, Jr., Owen M. Rogers, Willard E. Urban, Jr.

ASSISTANT PROFESSORS: Fred T. Hickson, J. Brent Loy

The interdepartmental Genetics Program offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

A qualified student is admitted to the program with the approval of the chairman of the department in which he has a major interest. Students will be expected to have adequate preparation in the biological and physical sciences including mathematics. Students lacking these requirements may be admitted but will be required to complete certain courses without graduate credit.

The Program is conducted by faculty members from the departments of Animal Sciences, Biochemistry, Botany, Forest Resources, Microbiology, Plant Science.

Genetics Program

and Zoology as well as other faculty from the Agricultural Experiment Station and the U. S. Forest Service, Northeastern Forest Experiment Station. Areas of specialization in the program are: the genetics of plants, animals, microorganisms, and viruses, with emphasis in physiological and quantitative genetics. All students working toward the M.S. or Ph.D. degree in Genetics are required to complete the core curriculum (Genetics 703, 705 and 770) unless equivalent courses have been satisfactorily completed elsewhere.

Master of Science Degree

The program for the Master of Science degree is formulated by the student with the approval of his guidance committee. Candidates for the degree will be required to complete a thesis, pass an oral examination covering graduate courses and thesis, and complete the core curriculum.

Doctor of Philosophy Degree

The chairman of the Genetics Program, with the concurrence of the chairman of the department of major interest, will nominate the student's guidance and doctoral committees. Specific course requirements will be developed by the student and his guidance committee, and will include the courses in the core curriculum. Students must complete a dissertation on original research in genetics.

A student must satisfy a foreign language requirement by either (a) demonstrating a reading knowledge of two foreign languages or (b) demonstrating high proficiency in one language. Satisfaction by either (a) or (b) may be by prior or concurrent formal training, or by examination, as determined by the student's guidance committee. High proficiency is judged (1) as completion of three year's formal training in a language or (2) from examination by a committee-appointed examiner.

Courses Available in the Genetics Program

703. Genetics

A course intended for students desiring more detailed training in fundamental genetics. This course and Genetics 705 and 770 are required for Genetics students. May be elected by others. Mr. Hoornbeek. Prerequisite: Zoology 604 or equivalent. 3 lectures; 1 laboratory; 4 credits.

705. Population Genetics

The distribution of genes in populations; factors affecting gene frequency such as mode of inheritance, departures from random mating, mutation, genetic drift, linkage disequilibrium, migration, selection, and fitness. Prerequisite: Zoology 604 and Forest Resources 528 or equivalents or permission of instructor. 4 credits. (Alternate years; offered in 1969-70.)

770. Biochemical Genetics

The biochemical mechanism of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochemistry 751 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

802. Design of Experiments

The philosophy of experimental design and how it relates to standard statistical designs. Topics include the roles of replication and randomization, factorially

arranged treatments, latin squares, incomplete non-factorial designs, fractional replication and confounding, and cross-over designs. Mr. Urban. Prerequisite: Forest Resources 711 and Mathematics 410 or permission of instructor. 3 credits. (Alternate years; offered in 1969-70.)

812. Advanced Statistical Methods

Methods and techniques for handling typical problems which arise in the analysis of data. Topics include the multiple comparison of means, analysis of un-weighted means, proportional subclass numbers, weighted squares of means, orthogonal polynomials, and least squares. Mr. Urban. Prerequisite: Forest Resources 711 and Mathematics 410 or permission of instructor. 3 credits. (Alternate years; not offered in 1969-70.)

821. Biometrical Genetics

Statistical aspects of estimating genetic parameters associated with quantitative traits. The theory underlying estimation of components of variance from various experimental designs, phenotypic and genotypic correlations, construction of selection indices, and the use of collateral and ancestral relatives to estimate breeding value. Mr. Urban. Prerequisite: Genetics 812, Mathematics 410, and either Animal Science 703 or Plant Science 774. 3 credits. (Alternate years; not offered in 1969-70.)

(898), 898. Genetics Seminar

Presentation and discussion of selected genetic topics. Staff. 1 credit. May be repeated.

899, (899). Master's Thesis

6-10 credits.

999, (999). Doctoral Research

Courses Available in the Cooperating Departments

These courses are fully described below and under the course descriptions of the appropriate department for the convenience of the student.

Animal Sciences (25)

708. Animal Genetics

Mendelian and quantitative inheritance in animals. Principles and systems of selection. Mr. Collins. Prerequisite: one course in genetics or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

811. Quantitative Genetics and Animal Improvement

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, and correlated characters. Mr. Collins. Prerequisite: one course each in genetics and statistics. 3 credits.

Botany (27)

732. Cytology

The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Schreiber. Prerequisite: one year each in the biological sciences and in chemistry. 3 lectures; 1 seminar; 4 credits.

Genetics Program

765. Microtechnique

A methods course in embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Miss Nast. Prerequisite: Botany 411 or 503. 2 lectures; 4 hours of laboratory; 4 credits. (Alternate years; not offered in 1969-70.)

Forest Resources (30)

711. Statistical Methods II

An intermediate course in statistics. Topics include basic concepts of sampling, linear models and analyses for one-way and multiway classifications, factorial arrangement of treatments, multiple regression, and covariance. Mr. Barrett. Prerequisite: Forest Resources 528 or equivalent. 4 credits.

730. Forest Tree Improvement

The genetics of forest tree improvement with emphasis on variation in natural populations, the basis for selection for desired characters, and the fundamentals of controlled breeding. The application of principles will be directed toward silviculture, management, and utilization. Mr. Hocker. Prerequisite: permission of instructor. 2 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1969-70.)

Microbiology (47)

804. Microbial Genetics

An introduction to genetic principles and methodology applicable to microorganisms; fine structure of genetic material, mutation, selection, adaptation, recombination, transformation, and transduction. Mr. Hickson. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

Plant Science (32)

773. Methods and Theory of Plant Breeding

Theory and use of plant breeding systems with emphasis on improving quantitative traits. Prerequisite: Genetics, Statistics. Mr. Peirce. 4 credits. (Alternate years; offered Fall 1970.)

832. Developmental Genetics

Relation to protein, RNA, and DNA synthesis in development, chromosome differentiation, nuclear-cytoplasmic interactions, genic and non-genic control of subcellular organization, cellular continuity, cell associations, experimental embryology, hormones and postembryonic development, gene regulation in development, and neoplastic growth. Mr. Loy. Prerequisite: permission of instructor. 3 credits. (Alternate years; offered Spring 1971.)

851. Plant Genetics

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 credits. (Alternate years; offered Fall 1969.)

853. Cytogenetics

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory technique in cytogenic analysis. Mr. Rogers. Prerequisite:

site: Genetics and Cytology. 2 lectures; 1 laboratory; 3 credits. (Alternate years; offered Fall 1970.)

Zoology (70)**836. Topics in Genetics**

Selected topics in fundamental and physiological genetics. Emphasis will be on recombination, phenogenetics and lethal genes. Mr. Hoornbeek. Prerequisite: Genetics 703 or equivalent. 3 lectures; 3 credits. (Offered alternate years; not offered in 1969-70.)

Geology (51)

Chairman: *Herbert Tischler*

PROFESSORS: Donald H. Chapman, Cecil J. Schneer, Herbert Tischler

ASSOCIATE PROFESSOR: Glenn W. Stuart

ASSISTANT PROFESSORS: Franz E. Anderson, Wallace A. Bothner, Henri E. Gaudette

Admission to graduate study in Geology will be granted to applicants who have had adequate preparation in the geological and cognate sciences. Students lacking these requirements may be admitted, but will be required to complete certain courses which do not give graduate credit. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and his thesis.

716. Mineralogy of Clays

The composition of various types of clays; the structure and properties of clay minerals; the origin and mode of occurrence of the clay minerals and clay materials; the utilization of clays in the arts and industry. Mr. Gaudette. Prerequisite: Geology 613, 512, or permission of instructor. 4 credits.

725. Igneous and Metamorphic Petrography

Igneous and metamorphic rocks in thin section; the optical identification of minerals and the significance of texture; the application of experimental petrology to petrogenesis. Mr. Bothner. Prerequisite: Geology 615, 622, or permission of instructor. 2 lectures; 1 laboratory; 4 credits.

741. Geochemistry

Applications of thermodynamics to geological processes; geochemical differentiation of the earth; the principles and processes which control the distribution and migration of elements in geological environments. Mr. Gaudette. Prerequisite: Geology 613 or permission of instructor. 4 credits.

754. Sedimentology

The properties of sediments and sedimentary rocks, the sedimentary processes and environments, correlation procedures and stratigraphic principles. Mr. Anderson and Mr. Tischler. Prerequisite: Geology 401 and 512 or permission of instructor. 2 lectures; 1 laboratory; 4 credits.

759. Geological Oceanography

The interaction between the marine and terrestrial environments; special emphasis on bathymetric features, continental shelf sedimentation, deep sea sedi-

Geology

mentation, and the discussion of recent marine geological hypotheses. Mr. Anderson. Prerequisite: Geology 501 and 754 or permission of instructor. 2 lectures; 1 discussion period; 4 credits.

771-772. Economic Geology

First semester: the types of coal and their occurrence in the United States; petroleum, the structures in which it is found and the distribution and geology of oil fields, especially in the United States; industrial minerals and their utilization. Second semester: the metals, their ores, and the geology of important ore deposits. Mr. Meyers. Prerequisite: Geology 512. 4 credits.

781. Physical Geology

The materials and structures of the earth and the erosive agents that modify them are described in the lectures and are examined and studied in the laboratory and on field trips. For high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing Geology 401 or equivalent.) 4 credits.

782. Historical Geology

The history and development of the physical features of the earth and the development of life on the earth. Fossil organisms will be briefly surveyed in the laboratory and the methods of historical geology will be illustrated in the laboratory and on field trips. Prerequisite: Geology 781 or equivalent. For high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing Geology 402 or equivalent.) 4 credits.

795. Geological Problems

Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed below. Staff. Prerequisite: permission of instructor. 1-2 credits. This course may be repeated to a total of not more than 5 credits.

- | | |
|---------------------------------|----------------------------------|
| 1. Areal Geology | 11. Mineralogy, Advanced |
| 2. Geochemistry | 12. Optical Crystallography |
| 3. Geomorphology, Advanced | 13. Ore Deposits |
| 4. Geophysics | 14. Paleontology, Advanced |
| 5. Glacial Geology, Advanced | 15. Petrology, Advanced |
| 6. Groundwater Geology | 16. Regional Geology |
| 7. Historical Geology, Advanced | 17. Sedimentation |
| 8. Industrial Minerals | 18. Stratigraphy |
| 9. Micropaleontology | 19. Structural Geology, Advanced |
| 10. Mineral Fuels | 20. Marine Geology |

797. Geology Seminar

Study of selected topics in both classical and modern geological thought. Prerequisite: senior standing and permission of instructor. 2 credits.

895, 896. Topics in Geology

An opportunity for advanced work on an individual or group basis. Prerequisite: permission of department chairman and staff concerned. 1-4 credits. Sections of this course are the same as those listed under Geology 795. May be repeated.

897, 898. Seminar in Contemporary Geology

A review and discussion of recent geological literature. The instructor, the format, and the content will vary from year to year. Prerequisite: permission of department chairman and staff concerned. May be repeated. 1-3 credits.

899. Master's Thesis

6-10 credits.

German and Russian

Acting Chairman: *James L. Sherman*

PROFESSOR: Hermann W. Reske

ASSISTANT PROFESSOR: Guenter Herr

The Department of German and Russian offers programs leading to the degrees of Master of Arts and Master of Science in Teaching (both degrees in German only).

To be admitted to graduate study for either degree, a student must have met requirements substantially equal to those set up for an undergraduate major in German.

To satisfy requirements for the degree of Master of Science in Teaching of German, the candidate must complete at least 30 credits of approved graduate work, including two courses in Education. At least three credits must be selected from the seminars listed below; one seminar paper will be required. The candidate for the degree must pass the departmental comprehensive written examination.

To satisfy requirements for the degree of Master of Arts in German, the candidate must pass the departmental comprehensive written examination and either: a) complete 30 credits of approved graduate course work with at least three credits selected from the list of seminars; one seminar paper will be required, or b) complete 24 credits of approved graduate course work and write a thesis. (Six credits are awarded for the thesis, thus completing the total 30 credits established by the Graduate School as requisite for the degree.) The departmental comprehensive written examination must be passed before the student undertakes work on the thesis. If the student takes the examination in German, he may write the thesis in English; if he takes the examination in English, he must write the thesis in German. If he wants to do both in German, he may do so. The thesis must embody the results of independent investigation and be written in a form acceptable to the Department. It must be submitted to the thesis director five weeks before the date the degree is to be granted.

A candidate for either the M.A. or M.S.T. degree will be permitted to take the departmental comprehensive written examination only twice. If he fails in his first attempt, he must wait at least three months before taking it again.

A student may do part of his graduate studies at the University of Marburg (West Germany). Normally, students spend one year in Marburg and one year (or the equivalent in summer school) at the Durham campus. Permission for UNH graduate students to participate in this program is given by the Department of German and the University of Marburg.

German and Russian

German (57)

701. Advanced Composition

A study of grammar and syntax. Composition of increased difficulty. Prerequisite: German 692 or equivalent. 3 credits. (Summer Session only.)

703-704. Advanced Oral Practice

For students with a fair knowledge of spoken German but who will need more fluency and accuracy of expression. Prerequisite: German 508. 3 credits. (Summer Session only.)

707. Practical Phonetics

A study of the sound and rhythm of spoken German. Classroom discussions are supplemented by intensive use of the language laboratory. 2 credits. (Summer Session only.)

826. German Culture and Civilization

A survey of the historical, social, artistic, and folkloristic developments in German-speaking countries from the beginning. Prerequisite: knowledge of German. 3 credits.

831. German Culture I, History

2 credits. (Summer Session only.)

832. German Culture II, Art

2 credits. (Summer Session only.)

833. German Culture III, Folklore

2 credits. (Summer Session only.)

842. Old High German

Linguistic analysis of Old High German grammar and its historical development. Selected readings in Old High German literature. 3 credits. (Alternate years; not offered in 1969-70.)

843. Introduction to Middle High German

An introduction into the phonology and grammar of Middle High German, taking into consideration their development from Germanic through Middle High German into New High German. Reading of outstanding lyrics. Prerequisite: German 606. 3 credits. (Alternate years; not offered in 1969-70.)

844. Middle High German Epics

Selections and interpretations of the important Middle High German epics. Prerequisite: German 743. 3 credits. (Alternate years; not offered in 1969-70.)

855. German Literature of the Age of Baroque

German literature between the Reformation and the Age of Enlightenment. Reading, interpretation, and critical analysis of prescribed prose, drama, and poetry with emphasis on the philosophical and social ideas of the time. Prerequisite: German 605-606. 3 credits. (Alternate years; offered in 1969-70.)

856. German Literature of the Age of Enlightenment

German literature from the Baroque period to the beginning of the period of Storm and Stress with emphasis on readings and interpretations of works of Lessing and Wieland. Prerequisite: German 605-606. 3 credits. (Alternate years; offered in 1969-70.)

857-858. The Age of Goethe

German literature of the Storm and Stress and the classical Periods. Interpretation and critical analysis with emphasis upon selected works of Wagner, Klinger, Lenz, Schiller, and Goethe. Prerequisite: German 605-606. 3 credits.

859. German Romanticism

German literature from the end of the Eighteenth Century to 1830. Interpretation and critical analysis of prescribed prose, drama, and poetry of prominent writers and poets of the period, from Wackenroder to Eichendorff. Prerequisite: German 605-606. 3 credits. (Alternate years; not offered in 1969-70.)

860. Kleist, Holderlin, Jean Paul

Outstanding authors outside the Romantic school. Prerequisite: German 605-606. 3 credits. (Alternate years; not offered in 1969-70.)

861. Literature of Biedermeier, Junges Deutschland, and Vormarz

Outstanding works of Grillparzer, Morike, Stifter, Heine, Büchner, and others will be read and discussed including social and philosophical developments of the post-Goethe period. Prerequisite: German 605-606. 3 credits. (Alternate years; offered in 1969-70.)

862. Age of Realism

Outstanding prose and lyrics of Keller, Meyer, Storm, Fontane, and others will be read and discussed including social and philosophical developments since 1848. Prerequisite: German 605-606. 3 credits. (Alternate years; offered in 1969-70.)

863-864. German Literature Since 1880

From Naturalism to the present. Reading, interpretation, and critical analysis of prescribed prose, drama, and poetry of Hauptmann, Hofmannstal, Rilke, Mann, Kafka. Prerequisite: German 605-606. 3 credits. (Alternate years; offered in 1969-70.)

879. Phonology of German

A contrastive analysis of the sounds of English and German. Phonetics, morphophonemics, and distinctive features. Prerequisite: knowledge of German. 3 credits.

880. Structure of Modern German

A grammatical analysis of modern German, employing structural, tagmemic, and transformational models. Prerequisite: knowledge of German. 3 credits.

881. History and Development of the German Language

An insight into the history and development of the German language. Beginning with the Indo-European Period, the changes in sounds, structure, and vocabulary are traced to the establishment of modern German. Prerequisite: German 686 or 692. 3 credits.

German and Russian

882. Advanced Stylistics

A systematic study of style, shades of meaning, adequacy of expression. A thorough knowledge of German grammar is prerequisite. Practice in writing seminar papers and obtaining stylistic flexibility in the use of written German. Training in bibliography. Prerequisite: German 686 or 692. 3 credits.

883. Seminar: Masterpieces of the Baroque Age

Prerequisite: German 755 or 855 or permission of instructor. 3 credits. (Alternate years; offered in 1969-70.)

884. Seminar: Masterpieces of the Age of Enlightenment

Prerequisite: German 756 or 856 or permission of instructor. 3 credits. (Alternate years; offered in 1969-70.)

885-886. Graduate Studies Abroad

A program of studies at the University of Marburg (West Germany) for students who have been admitted to the Graduate School of the University of New Hampshire. A wide range of courses and subjects are offered to the students participating in this program, including courses in Germanic languages and literature as well as cognate fields.

887. Seminar: Masterpieces of the Age of Goethe

Prerequisite: German 758 or 858 or permission of instructor. 3 credits. (Alternate years; not offered in 1969-70.)

888. Seminar: Masterpieces of Nineteenth Century German Literature

Prerequisite: permission of instructor. 3 credits. (Alternate years; not offered in 1969-70.)

889. Seminar: Masterpieces of German Literature Since 1880

Prerequisite: German 764 or 864 or permission of instructor. 3 credits. (Alternate years; offered in 1969-70.)

891. Methods of the Teaching of German

A critical study of modern language teaching on all levels from high school to college. The course emphasizes the practical approach to teaching and the use of modern equipment, such as audio-visual aids, tape recorders, films, etc. The course is especially tailored for teachers of German in high schools and colleges. 3 credits.

895-896. Special Studies in Germanic Languages and Literature

Courses of study in special topics. Examples of topics which may be selected by instructors and students are: Gothic, Old Icelandic, Medieval and Renaissance Drama, Grimmelshausen: *Simplicissimus*, Goethe's *Wilhelm Meister*, Heinrich von Kleist, German lyrics of the 19th Century, 19th Century Bildungsroman, post-war German novel, etc. Prerequisite: permission of instructor. 3 credits.

899. Master's Thesis

History (53)

Chairman: *William R. Jones*

PROFESSORS: H. Trevor Colbourn, William Greenleaf, Hans Heilbronner, David F. Long, Darrett B. Rutman

ASSOCIATE PROFESSORS: Robert C. Gilmore, Marion E. James, Charles A. Jellison, William R. Jones

ASSISTANT PROFESSORS: Charles E. Clark, Marc L. Schwarz, Douglas L. Wheeler

DIRECTOR OF GRADUATE STUDIES: Darrett B. Rutman

The Department of History offers programs leading to the degree of Master of Arts and Doctor of Philosophy. The Department considers that a substantial foundation in history is prerequisite to beginning work on the graduate level. Consequently it usually requires completion on an undergraduate level of the equivalent of a history major at this University (8 semester courses in history) and some preparation in other areas of the humanities and social sciences. The Department also recommends, although it does not absolutely require, that a beginning graduate student have some training in a foreign language. Applicants should submit aptitude and history scores on the Graduate Record Examinations. Applicants intending the Ph.D. degree should include with their applications a personal letter indicating their reason for and intentions in undertaking graduate study.

Master of Arts

The Master's degree may be undertaken as a terminal degree or as preparation for a Ph.D. program. A successful candidate shall complete with grades of P or better at least 8 semester courses in history numbered above 700, of which a minimum of 4 shall be numbered between 800 and 898. In addition, the candidate will complete a thesis satisfactory to his thesis committee. Upon the recommendation of the Department a student may substitute 2 additional semester courses for the thesis. (The preparation of the thesis is considered to be the equivalent of 2 semester courses each bearing the designation History 899 for the purpose of meeting the general regulations of the Graduate School as stated earlier in this Bulletin.) The completed thesis must be submitted by April 1 of the year in which the degree is to be granted. A final examination is not required. Students intending a Ph.D. degree normally include as part of their work either or both of the following which they have not completed as undergraduates: Language training to the extent of competence in one foreign language; and surveys of American and European historiography, equivalent of History 723 and 774.

Doctor of Philosophy

The degree of Doctor of Philosophy is not essentially a course-related degree. It is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examinations covering one major field of history with emphasis upon that subfield of specialization in which the student will prepare his dissertation, two subfields outside the major field, and a cognate field outside of history or a field of non-western history. At present dissertations are limited to the major field of American history with the subfields Early America (to ca. 1815) and Modern America (since ca. 1815). Prior to admission to a doctoral

History

program the student is required to demonstrate competence in one foreign language; prior to admission to qualifying examinations he is required to demonstrate competence in a second language or a special research technique.

Apprenticeship

The Department considers that graduate work in history, and particularly doctoral work, is professional training. All entering graduate students intending a Ph.D. are, consequently, required (and all others are urged) to participate on a continuing basis in History 801, Proseminar: History as a Profession. Moreover, the Department recognizes the dual concerns of the historian's life—research and teaching. All doctoral students, consequently, are expected to undertake teaching assistantships in the Department during a part of their residence. Participation in proseminar and as a teaching assistant constitutes an apprenticeship conjunctive with, but apart from, formal study.

A complete guide to the Department's graduate regulations and practices is available from its Director of Graduate Studies.

703. The Colonial Period of American History

Anglo-America from the late sixteenth century to the mid-eighteenth century, encompassing a general and interpretative view of the development of an Anglo-American culture along the eastern seaboard of North America. Mr. Clark, Mr. Colbourn, Mr. Gilmore, Mr. Rutman. 4 credits.

704. Sources and Methods of Colonial American History

An introduction to the materials and methodology of the historian of Anglo-America, structured around a series of problems underlying the interpretations considered in 703; specific approaches to these materials; and what historians have done with the materials. Mr. Rutman. Prerequisite: History 703 and (for graduate students) permission of the instructor. 4 credits.

705, 706. America in the Eighteenth Century and the Revolution

American Colonial and Revolutionary history during the period from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. Mr. Gilmore. 4 credits.

711, 712. Nineteenth Century America

The historical factors, both domestic and international, involved in the development of the American Republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. Mr. Jellison. 4 credits.

715, 716. Twentieth Century America

United States history since 1896, from the triumph of industrialism on the national scene to the emergence of America as a world power in the nuclear age. Political, economic, and diplomatic developments. Mr. Greenleaf. 4 credits.

719, 720. The Foreign Relations of the United States

Primarily the history of American diplomacy, with attention given to the non-diplomatic aspects of foreign relations. Mr. Long. 4 credits.

721, 722. Social and Intellectual History of the United States

The development of American thought and society, with emphasis on the relationship between ideas and events. The first semester, approximately one-half of which is devoted to the period before the American Revolution, covers topics of fundamental importance to the growth of American civilization from the beginning of English settlement to the eve of the Civil War. The second semester deals with similar topics and issues during the period from the Civil War to the present. Mr. Clark. 4 credits.

723. American Historiography

The principal writings of American historians from the colonial period to the present time. Emphasis will be given to those works that pertain mainly to the American people and their immediate neighbors. Mr. Jellison. Prerequisite: permission of instructor. 4 credits.

739, 740. Three Medieval Civilizations

The demise of classical antiquity in the lands bordering the Mediterranean and the genesis and fruition of three new cultural traditions: the Latin Christian, the Islamic, and the Byzantine. Religious, literary, and scholarly survivals and innovations from 400 A.D. to 1400 A.D. Mr. Jones. 4 credits.

743. Renaissance and Reformation

The history of Europe during the fifteenth and sixteenth centuries with primary emphasis on the Italian Renaissance, the Protestant Reformation, and the emergence of the national state. 4 credits.

747. The Age of Absolutism

The theory and practice of absolutism from its origin in the seventeenth century to its apogee in enlightened despotism. 4 credits.

749. The Age of Revolution

Revolution as a socio-political phenomenon in its historical setting. Comparative approach to Puritan, American, and French revolutions with reference to contemporary movements. Mr. Gilmore. 4 credits.

756. Twentieth Century Europe

European history in the twentieth century will be treated from the point of view of a civilization in a constant state of crisis. World War I, the inter-war period, World War II, and the attempts to solve the conflicts of modern society after that war in terms of new economic, political, and cultural patterns will represent the core of the study. The effects of extra-European influences, the loss of European primacy, and continued strife within the structure of the European state and cultural system. Mr. Heilbronner. 4 credits.

759. History of Modern Spain and Portugal

The Iberian states and their peoples from the coming of nineteenth-century liberalism to the present. Political and social change will be emphasized but attention will be paid to imperial activity as well as to intellectual movements. External influences of European thought and activity will be considered as relevant to the study of two modernizing countries with persistent traditions. Mr. Wheeler. 4 credits.

History

761, 762. England in the Tudor and Stuart Periods

An examination of the political, religious, socio-economic, and intellectual forces for change at work in England from the accession of Henry VII to the Revolution of 1688-89. Mr. Schwarz. 4 credits.

763, 764. History of Russia

The development of the Russian state from its foundation to its present status as a world power. The course is designed to increase the understanding of the present in terms of the past. Political developments, foreign relations, and intellectual and ideological currents. Mr. Heilbronner. 4 credits.

767, 768. History of Germany

Germany and the various German states from the Reformation to the Third Reich and the presently divided Germany. The course will emphasize the relationship and importance of Germany to the rest of Europe. Mr. Lentz. 4 credits.

774. European Historiography

An examination of selected works of historical literature since the Reformation. Emphasis will be placed on the comparison of different schools of historical interpretation, the development of historical method, and the impact of Romanticism, Idealism, Nationalism, and Positivism on the composition of historical literature. 4 credits.

777, 778. The Hellenistic-Roman World

History of the Ancient World from the death of Alexander in 323 B.C. to the end of Constantine's reign in 337 A.D. Major political, economic, and social developments, and consideration of artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity and the transformation of the classical world. Miss James. 4 credits.

(781). History of Modern China, 1850-1950.

The modernization of China. The political, social, and cultural changes which have occurred in China from its early contacts with the West to the establishment of the Communist regime. Mr. Linden. 4 credits.

784. History of Southern Africa Since 1820.

The struggle for political and economic control in the only region of Africa where European groups remain in power. With special attention to the development of European hegemony. The course will trace the impact of European imperialism, European settler nationalism, African nationalism, racial conflict, economic competition and industrialization, Apartheid, and assimilation. Included will be a discussion of official American policy in this region. Mr. Wheeler. 4 credits.

785. The Modern Middle East

A history of the Middle East from the eighteenth century to the present time, with special attention given to the problems created by modernization and reform of the traditional society, the conservative reaction to reform, the impact of nationalism, and the appearance of new ideologies. Mr. Voll. 4 credits.

(789). Seminar in the History of Science

Selected topics, conducted through special lectures, individual study, and oral and written reports. The subject will vary from year to year. This course is the same as Physical Science (789). *Cannot be used for credit in History without permission of the History Department.* Mr. Schneer. Prerequisite: permission of adviser and instructor. 4 credits.

791. History-Education (Hist-Ed). Problems in the Teaching of High-School History and Other Social Studies

Bibliography and new interpretations of history; the social-studies curriculum, past and present; aims and objectives in the social studies; selection and organization of teaching material; teaching and testing techniques. Special emphasis on teaching American history and the problems of American democracy. Open to students who have satisfactorily completed History 503, 504; six credits in other history courses, exclusive of History 401, 402; six credits from American Government, Principles of Economics, or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. Mr. Draves. 4 credits.

(793). World History

History from the perspective of the experience of the whole human community. The histories of separate areas will be examined in terms of their relationship to the general historical experience of man. Problems of interpretation, inter-relationships, similarities, and differences in the development of the major traditions of civilization. Students will present oral and written reports as a basis for discussions. Mr. Voll. Prerequisite: permission of instructor. 4 credits.

(799). Colloquia in History

Selected topics in American, European, and non-Western history. Staff. Prerequisite: permission of the instructor. 4 credits.

Graduate Readings and Seminars**803. Readings in the Colonial Period of American History**

Extensive and directed readings in the history of Anglo-America from the late sixteenth century to mid-eighteenth century, encompassing the historiography of the period but stressing the scholarship of the last two decades. Mr. Rutman. Prerequisite: permission of the instructor. 3 credits.

804. Seminar in the Colonial Period of American History

Directed research and writing in the history of Anglo-America from the late sixteenth to mid-eighteenth century. Mr. Rutman. Prerequisite: permission of the instructor. 3 credits.

805, 806. Seminar in the American Revolutionary Period

American Colonial and Revolutionary history from 1740 through the establishment of Washington's first administration. Mr. Gilmore. 3 credits.

811, 812. Seminar in Nineteenth Century American History

For students interested in examining in depth certain significant conditions, trends, and aspects of American society during the nineteenth century. Mr. Jellison. Prerequisite: a course in United States history and permission of instructor. 3 credits.

History

815, 816. Seminar in Twentieth Century American History

A specialized and analytical study of movements, institutions, personalities, and problems which have played a shaping role in the development of the United States between 1896 and the middle of the twentieth century. Research papers pertinent to seminar discussions will be required. Mr. Greenleaf. Prerequisite: a course in United States history and permission of instructor. 3 credits.

821, 822. Seminar in the Social and Intellectual History of the United States

Selected topics in the history of American thought and culture, the study of which will include instruction and practice in the techniques of research in primary materials and in the writing of history, together with a grounding in the historiography of the topic under discussion. Each student must produce a major research paper in addition to a number of other written exercises. The topic will frequently, but not invariably, be chosen from the seventeenth, eighteenth, or early nineteenth century. Mr. Clark. Prerequisite: appropriate introductory acquaintance with the topic and period, to be determined by the instructor. 3 credits.

835, 836. Seminar in Modern European History

Specialization in the study of the development of some major institutions and ideas which have contributed to the structure and spirit of modern society. Research papers, relating to seminar discussions, will be required. Prerequisite: a course in modern European history and permission of instructor.

861, 862. Seminar in the History of England in the Tudor and Stuart Periods

A consideration of, and research in, selected topics with particular emphasis on the English Reformation and the Puritan Revolution. Mr. Schwarz. Prerequisite: a course in English history and/or permission of instructor.

863, 864. Seminar in Russian History

The seminar will be concerned with the study of, and research in, specific, limited topics in nineteenth and twentieth century Imperial and Soviet history. Mr. Heilbronner. Prerequisite: a course in Russian history and permission of instructor.

895, 896. Reading and Research in History:

(1) American Colonial History, (2) United States Since 1789, (3) Canada and Latin America, (4) Medieval Europe, (5) Modern Europe, (6) Ancient History, (7) Far East and India, (8) Near East and Africa, (9) European Historiography, (10) American Historiography, (11) Russia, (12) World History.

For independent study in an area in which no appropriate course is offered. To be chosen by a graduate student in history who wishes to take courses normally not open to him on a graduate basis. Hours to be arranged. Staff. Prerequisite: permission of instructor.

(899.) Master's Thesis

999. Doctoral Research

Home Economics (31)

Chairman: *Marjory A. Wybourn*

PROFESSOR: Marjory A. Wybourn

ASSOCIATE PROFESSORS: Earl O. Goodman Jr., Mary Holder, Elizabeth M. Rand, James L. Spangenberg

ASSISTANT PROFESSOR: Sylvia H. Marple

Graduate work is offered leading to the degree of Master of Science in Home Economics, with major emphasis in areas which strengthen professional competence in family, community, and educational services.

Each student's program will be planned to achieve personal and professional objectives of the individual and be based on specific interests, ability, and undergraduate preparation. Selection of courses from the social sciences and other University departments will be encouraged.

Students admitted to the graduate program in Home Economics are expected to have had an undergraduate degree in Home Economics or a related field. If there are deficiencies in the undergraduate program, students may be admitted on condition that they complete specified prerequisites.

A candidate for a Master of Science degree in Home Economics is expected to fulfill the general requirements of the Graduate School and the following departmental requirements:

1. Home Economics — a minimum of 12 semester credits, including one course in each of the following two areas: management and decision-making in the family and family development.
2. A minimum of 9 semester credits selected from the liberal arts or other areas which support the major.
3. Research — a minimum of 4 semester credits, including Home Economics 897, Research Seminar, and Home Economics 898. Research Project, or Home Economics 899, Thesis.

707. Practicum with Children and Families

A planned, supervised experience with children or families at both participating and observing levels. The practicum is designed to increase the students' awareness and understanding of the ways human beings grow and behave and the dynamics of the family and community settings. Weekly class discussions will be combined with individual and small-group supervisory conferences. Students have the opportunity to choose a focus for their practicum from among the following: 1) young children — preschool program, 2) school-age children, 3) adolescents, 4) adults and parents, and 5) low-income families — management experiences. Limited to Home Economics majors. Prerequisite: department permission and 6 credits in one area. One or more semesters, maximum of 6 credits. 2 or 4 credits.

715. Clothing in Relation to Human Behavior

The analysis of research and theory in the social-psychological aspects of clothing. An exploration and study of clothing behavior of individuals and groups. Special emphasis given to stages of the life cycle, development of the self, and the phenomenon of fashion. 4 credits.

Home Economics

725. Preschool Programs

A study of the organization and operation of programs for young children. Theoretical knowledge about children and educational techniques will be related to the curriculum, facilities, and administration in a variety of group programs for young children. Field trips will be planned. Prerequisite: Home Economics 627 or equivalent. Limited to Home Economics majors or permission of instructor. 4 credits.

754. Personal and Family Finance

A study of major financial alternatives available to families during the various stages of the family life cycle. 4 credits.

774. Nutrition and Disease

Application of the principles of normal nutrition to clinical problems, with a description of altered nutrient requirements in human disease. Diet therapy as an applied aspect of clinical nutrition is considered. A practicum in a field situation will be a part of the experience. Prerequisite: Home Economics 573 or equivalent. 4 credits.

776. Nutrition—A World View

Study of the major nutritional problems facing the world today. Consideration of protein—calorie malnutrition, obesity, nutritional status of adolescents, and special nutritional problems of pregnancy, infancy, childhood, and the aging. An exploration of concepts and methodologies for nutrition education. Prerequisite: Home Economics 573 or equivalent. 4 credits.

786. Dynamics of Family Change

The major focus of this course is an examination of the theories and supporting research of the intervention techniques used to affect changes in family behavior. The secondary focus is the student's examination of his interaction processes and their effect on intervention efforts. Prerequisite: Home Economics 683 and Psychology 545 or permission of instructor. 4 credits.

883. Human Sexual Behavior

An exploration of contemporary opinion and research on human sexual behavior and related issues of education. Programs and resources for sex education in home, school, church, and community will be examined and criteria sought to evaluate them. For school personnel, parents, and others who will work closely with children, youth, and families. 3 credits.

892. Methods in Family Relation Education

A study of the methods and materials used in family relations education in high schools, colleges, churches, and social agencies. The methods will be applied through role play and field experience. The course assumes mastery of the basic principles of family relations, human development, and theories of intervention. 4 credits.

895. Seminar and Special Problems

The seminars are open to graduate students with sufficient background for in-depth study in any of the following areas: 1) clothing and textiles, 2) consumer education, 3) family relations, 4) food and nutrition, 5) home eco-

Interdisciplinary Options and Programs

nomics education, 6) management and family finance, and 7) human development. The student will contribute to a selective review and critical evaluation of the research and current literature and an examination of issues and trends. Independent projects may be a part of the experience. These seminars will not be scheduled every semester. One or more semesters, maximum of 4 credits in one area. 2 to 4 credits.

897. Research Seminar

Survey, evaluation, and use of research in the field of home economics. An introduction to methods and techniques used in defining a problem for study, collecting data, analyzing, and writing a report. 2 credits.

898. Research Project

A study or project which may be selected in lieu of a thesis. To be taken concurrently or following Home Economics 897. 2-4 credits.

899. Thesis

6 credits.

Interdisciplinary Options and Programs

Soil and Water Chemistry Option

The chemist can contribute much to the advancement of many scientific disciplines through the application of the principles of chemistry to research problems in these other disciplines. The Departments of Chemistry and Soil and Water Science have instituted an option in the Doctor of Philosophy program in Chemistry which enables the graduate student to apply his chemistry background to research problems of mutual interest to the two departments. A student entering this option must meet the entrance requirements for the Doctor of Philosophy program in Chemistry. So that the student may obtain a background in Soil and Water Science, he will be permitted to substitute graduate level courses in Soil and Water Science for certain courses in Chemistry. His dissertation will be on a basic problem of interest to faculty members in both departments. For further information, write to either the Department of Soil and Water Science or to the Department of Chemistry.

Chemical Physics Option

Doctor of Philosophy candidates in Chemistry may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Physics. In this option the doctoral student, with the advice of his guidance committee, elects courses in chemistry and physics (or, in some cases, mathematics), writes his dissertation on a research problem (experimental, theoretical, or both) appropriate to interdisciplinary treatment and receives the doctorate in either Chemistry or Physics. In addition, each candidate must satisfy certain other requirements of the department in which the degree is granted. Ordinarily, students choosing the Chemical Physics option are expected to have undergraduate degrees in chemistry, physics, or mathematics and reasonably strong backgrounds in the other two disciplines.

Mathematics

Zoology Option

Faculty from departments related to Zoology, such as Animal Sciences and Entomology, may direct master's and doctoral dissertations.

Marine Science — Oceanography

The University of New Hampshire has long had an interest in marine science. The location of the University on the Great Bay and its tidal estuaries provides a natural laboratory for marine sciences including oceanography and marine-oriented biochemistry, botany, geology, microbiology, and zoology. The construction of the new Jackson Estuarine Laboratory, which will be ready for use in the spring of 1969, is evidence of the heightened interest in marine studies. A prospective graduate student who wishes to emphasize marine science or oceanography in his graduate work may do so by selecting courses in the departments of Biochemistry, Botany, Geology, Microbiology, or Zoology. For further information, write to the Office of Marine Science and Technology.

Ocean Engineering — EDAL

The Engineering Design and Analysis Laboratory is an interdisciplinary faculty group mainly from the College of Technology. This group, early in its history, chose to make ocean-oriented engineering its principal, but not exclusive, interest. The stated purpose of EDAL is to involve both faculty and students in realistic and challenging engineering projects. Projects thus far accomplished have made both EDAL-associated faculty and EDAL-associated graduate students participants in marine-oriented engineering. Prospective graduate students who are interested in joining EDAL should write to the Office of Marine Science and Technology for further information.

Mathematics (84)

Chairman: *M. Evans Munroe*

PROFESSORS: Richard H. Balomenos, Edward H. Batho, Arthur H. Copeland, A. Robb Jacoby, Richard E. Johnson, Shan S. Kuo, M. Evans Munroe, James Radlow, Shepley L. Ross, Robert J. Silverman

ASSOCIATE PROFESSORS: Homer F. Bechtell, William E. Bonniece, David M. Burton

ASSISTANT PROFESSORS: Merle D. Guay, Roger H. Hou, Eric A. Nordgren, Samuel D. Shore, Christopher C. White, William G. Witthoft

The Mathematics Department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy.

Master of Science for Teachers

Admission requirements: Completion of all requirements for secondary school teacher certification in Mathematics. Degree requirements: (1) Ten semester courses approved by the Department. These will normally be taken from the courses numbered 801-829 and will usually include the six courses numbered 803-808. (2) A comprehensive examination based primarily on material in courses 803-808. It is not possible to work full time during the academic year toward the Master of Science for Teachers degree. The courses in this program are offered primarily in summer institutes.

Master of Science

Admission requirements: Mathematics 761-762 or 767-768 or the equivalent of one of these sequences elsewhere. Preference will be given to applicants who have completed both these sequences. Degree requirements: Ten semester courses approved by the Department. These must be chosen from courses numbered 701-799 or 830-899. At least six of the ten must be from the 830-899 group.

Doctor of Philosophy

Admission requirements: Same as for Master of Science. Degree requirements: (1) Course work as prescribed by the Department. This will normally include all the courses numbered 833-842 together with several courses numbered 860-898. (2) Proficiency in reading mathematical literature in two of the three languages: French, German, and Russian. (3) Experience in teaching, equivalent to at least one-half time for one year. (4) Qualifying examination. This is in two parts. The first part (written) must be taken after three semesters in residence. It will cover basic topics in graduate level mathematics. The second part (oral) is normally taken in the third year and covers more advanced topics. (5) Thesis. This is the principal item in the doctoral program. New and original results will be required. At present, thesis work is available in the fields of algebra, analysis, and topology.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

635. Partial Differential Equations

Sturm-Liouville problems; exact and approximate determination of characteristic values and functions; Fourier series and Fourier integrals; solution of boundary value problems for partial differential equations by series and integrals; classification, cononical forms, and basic concepts of second order; linear partial differential equations; elliptic, parabolic, and hyperbolic equations. Prerequisite: Mathematics 527, 528. 4 credits.

640. Linear Algebra

Vector spaces, matrix algebra, bases and linear transformations, determinants, inner products, quadratic forms. Prerequisite: Mathematics 426. 4 credits.

656. Introduction to Number Theory

Unique factorization, linear and quadratic congruences, quadratic reciprocity law, arithmetic functions, quadratic forms, and introduction to algebraic numbers. Prerequisite: Mathematics 640. 4 credits.

657. Geometry I

Fundamental properties of Euclidean geometry from an advanced standpoint. Prerequisite: Mathematics 640. 4 credits.

658. Geometry II

Systems of postulates of various geometries, geometric invariants, synthetic and analytic projective geometry, introduction to non-Euclidean geometry. Prerequisite: Mathematics 640. 4 credits.

682. Non-Linear Differential Equations

Phase plane analysis of linear and non-linear autonomous systems; critical points; limit cycles; periodic solutions; approximate methods for second order,

Mathematics

non-linear, ordinary differential equations; stability and asymptotic behavior of solutions of linear and non-linear equations. Prerequisite: Mathematics 527. 4 credits.

A maximum of four of the following courses may be applied to the degree of Master of Science in Mathematics.

710. Advanced Programming Systems

An introduction to computer systems organization, machine language, and digital representation of data. Software studies are compilers, assemblers, loaders, system utility program, and macros. All programming will be done in Basic Assembly Language on the IBM 360. Prerequisite: Mathematics 410 or equivalent. No credit given to students who have passed Mathematics 754. 4 credits.

735. Probability

Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson and normal distributions; limit theorems for sums of random variables. Prerequisite: Mathematics 528. 4 credits.

736. Statistics

Sampling theory, estimation of parameters, testing of hypotheses, non-parametric methods. Prerequisite: Mathematics 735. 4 credits.

753-754. Numerical Methods and Computers

This course is oriented toward the use of numerical analysis on digital computers (with laboratory). Computer organization, algorithmic languages and compilers, solution of polynomial and transcendental equations, numerical solutions of differential equations, linear systems of equations, eigenvalues and eigenvectors, polynomial interpolation, quadrature, curve fitting, discussion of errors, systems simulations, and mathematical optimization techniques. Selected algorithms will be programmed for solution on high-speed computers in the Computation Center. Prerequisite: Mathematics 401 and 527. 4 credits.

763-764. Abstract Algebra

Groups, rings, integral domains, fields, and linear algebra. Prerequisite: Mathematics 640. 4 credits.

767-768. Real Analysis

Topology of the real line, metric spaces, topology of Euclidean spaces, limits, sequences and series, continuity, differentiation, integration, uniformity of limit operations, equicontinuity, function spaces, inverse and implicit function theorems. Prerequisite: Mathematics 528. 4 credits.

776. Logic

Development of formal mathematics. Discussion within that system of formal systems. Consistency, completeness, decidability. Prerequisite: consent of the instructor. 4 credits.

780. Theory of Ordinary Differential Equations

Fundamental existence and uniqueness theorems; linear systems and higher order linear equations; Wronskian theory; classical Sturm Theorem and generaliza-

tions; boundary value problems for second order linear equations. Prerequisite: Mathematics 527, 640, and 767. 4 credits.

784. Topology

Basic topological notions, connectedness, compactness, metrizability, with special emphasis on the real line and plane. Prerequisite: Mathematics 767. 4 credits.

788. Complex Analysis

Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, and conformal mapping. Prerequisite: Mathematics 528. 4 credits.

795. Calculus on Manifolds

Differentiable manifolds; differential forms; exterior and Grassman algebras; integration of differential forms; Stokes theorem; closed and exact differential forms. Prerequisite: Mathematics 640 and 767. 4 credits.

The following courses may be applied to the degree of Master of Science for Teachers in Mathematics and to no other graduate degree in Mathematics.

801-802. Fundamental Concepts of Mathematics for Teachers

An introduction to the most fundamental concepts of analysis, geometry, and algebra. Basic elements of set theory; a survey of the real and complex number systems; the integers and the concept of an integral domain; introduction to groups; geometries, Euclidean and non-Euclidean; functions, sequences, and the limit concept; the derivative and the differentiation of algebraic functions. 3 credits.

803-804. Higher Algebra for Teachers

The integers, integral domains, and topics from number theory; equivalent relations and congruences; real numbers, complex numbers, and fields; polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 credits.

805-806. Higher Geometry for Teachers

Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry; and topology. 3 credits.

807-808. Higher Analysis for Teachers

The real number system; variables, functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. 3 credits.

809. Probability and Statistics for Teachers

Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 credits.

811. Computers and Their Uses

Computing machines and modern numerical methods. Each student will have an opportunity to make use of the University computer. 3 credits.

814. Theory of Numbers for Teachers

Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 credits.

816. Theory of Numbers for Teachers

Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. 3 credits.

817. Theory of Sets and Elementary Logic

An introduction. 3 credits.

819. The Real Number System

A postulational approach. Brief discussion of algebraic structures. Introduction to the sequences, limits, and continuity. 3 credits.

820. History of Mathematics

A problem-study approach to mathematical problems and solutions from the period of Greek mathematics until the 1950's will be used to present the history of mathematics. 3 credits.

821. A Modern Approach to Geometry

The foundations and development of Euclidean geometry, with emphasis on the recent School Mathematics Study Group's recommendations in the field of high school geometry. 3 credits.

825. Internship

Experience under the direction of a master teacher in teaching university level mathematics to superior high school students. This work will be done in the Advanced Studies Program at St. Paul's School, Concord, New Hampshire. 6 credits.

826. Selected Topics in Algebra

Topics selected to supplement the teacher's previous training in algebra, chosen from the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 credits.

827. Selected Topics in Geometry

Topics selected to supplement the teacher's previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 credits.

828. Selected Topics in Analysis

Topics selected to supplement the teacher's previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 credits.

829. Directed Reading

A directed reading project on a selected topic in mathematics chosen to supplement the teacher's previous institute courses. A written examination will be required. 3 credits.

The following are the basic courses for both the Master of Science and Doctor of Philosophy Degrees in Mathematics.

831. Set Theory

Foundations of the theory of sets; ordinal and cardinal numbers; Zorn's lemma; applications. 3 credits.

833-834. Algebra

Groups; rings; modules, fields; linear algebra. 3 credits.

835-836. Real Analysis

Outer measures and measures; Lebesgue integrals; convergence theorems; Banach spaces; representation of linear functionals; weak and weak* topologies. 3 credits.

837-838. Complex Analysis

Complex variables and functions; analytic functions; complex integration; series, products; conformal mapping; analytic continuation and Riemann surfaces. 3 credits.

839-840. General Topology

Topological spaces; nets and filters; product and quotient spaces; embedding and metrization; compact spaces; uniform spaces; homotopy and fundamental group; covering spaces and fibrations. 3 credits.

841-842. Algebraic Topology

Chain complexes; homology of simplicial complexes; singular homology and cohomology; axiomatic homology; cup and cap products; topological manifolds; sheaves. 3 credits.

851-852. Differential Equations

Ordinary differential equations; existence theory; linear equations; Sturm-Liouville theory; nonlinear autonomous systems; Poincare-Bendixson theory; partial differential equations; second order linear equations; initial value problems; hyperbolic equations; the Dirichlet problem. 3 credits.

855-856. Applied Mathematics

Calculus of variations, integral equations; operator theory; distributions; Hilbert spaces. 3 credits.

The following are advanced courses primarily for Doctor of Philosophy candidates, though they may be elected by qualified Master of Science candidates. In each of these the content will vary from year to year. Thus, with permission of the instructor, each of these courses may be taken more than once for credits, even concurrently. Normally, the content will be chosen from among the topics listed.

861, 862. Topics in Algebra

Algebraic number theory; algebraic geometry; ring theory; theory of modules; group theory; non-associative algebras. 3 credits.

Mechanical Engineering

863, 864. Topics in Analysis

Measure theory; calculus of variations; integral equations; boundary-value problems; orthogonal series; theory of approximation; analytic number theory; Riemann surfaces. 3 credits.

865, 866. Topics in Topology

Algebraic topology; theory of sheaves; dimension theory; Riemann surfaces; homotopy theory. 3 credits.

867, 868. Topics in Geometry

Convexity; projective geometry; differential geometry; tensor analysis. 3 credits.

869, 870. Topics in Topological and Algebraic Analysis

Rings of functions; linear topological spaces; topological algebras; Hilbert spaces; rings of operators; topological groups; Lie groups; harmonic analysis. 3 credits.

871, 872. Topics in Differential Equations

Boundary value problems; asymptotic behavior and stability theory; non-linear equations; dynamic systems; classical theory of partial differential equations; functional analysis and partial differential equations. 3 credits.

873, 874. Topics in Applied Mathematics

Linear and dynamic programming; differential equations; special functions. 3 credits.

875, 876. Topics in Probability and Statistics

Stochastic processes. 3 credits.

898. Reading Courses

Offered in the following areas: (a) Algebra, (b) Analysis, (c) Topology, (d) Geometry, (e) Topological and Algebraic Analysis, (f) Differential Equations. (g) Applied Mathematics, (h) Probability and Statistics. 3-6 credits.

999. Doctor of Philosophy Thesis

Mechanical Engineering (85)

Chairman: Robert W. Corell

PROFESSORS: Robert W. Corell, Godfrey H. Savage, Charles K. Taft, Asim Yildiz

ADJUNCT PROFESSOR: Wayne M. Beasley

ASSOCIATE PROFESSORS: Victor D. Azzi, Frederick G. Hochgraf, William Mosberg, Douglas M. Norris Jr., Russell L. Valentine

ASSISTANT PROFESSORS: Robert W. Alperi, W. Tseng Yang

DIRECTOR OF GRADUATE STUDIES: Douglas M. Norris Jr.

The Mechanical Engineering Department offers programs of study, from the viewpoint both of the engineering sciences and of engineering design, in mechanics, materials, and the thermal sciences leading to the degree of Master of Science in

Mechanical Engineering. The programs provide the background required for careers in research, engineering design or teaching, or for further graduate study.

To be admitted to graduate study in Mechanical Engineering, a student should have completed work equivalent to that required at the University of New Hampshire for a Bachelor of Science degree in his field.

A candidate for the degree of Master of Science shall satisfy the requirements of either a thesis plan or a project plan. The thesis plan requires 24 semester hours of course work in addition to Mechanical Engineering 899, Master's Thesis; the project plan requires 30 semester hours of course work in addition to Mechanical Engineering 892, Master's Project. Individuals with special qualifications may petition the Department to be excused from the project requirement. An oral examination covering the candidate's graduate work will be given whether or not a thesis is presented.

Students completing degree requirements through the University Extension Service must be admitted to the Graduate School and have their programs approved by the Department.

No more than two graduate courses taken prior to admission to the Graduate School may be applied to the Master's degree. Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

Permission of the instructor and consent of the adviser is required for enrollment in all Mechanical Engineering graduate courses.

701. Macroscopic Thermodynamics

A continuation of the study of thermodynamic principles using an analytical approach consistent with that of Gibbs and Caratheodory. 4 credits.

702. Statistical Thermodynamics

An introduction to statistical thermodynamics. 4 credits.

703. Heat Transfer

Analysis of heat transfer phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. 4 credits.

704. Experimental Heat Transfer

Experimental methods in the study and solution of heat transfer problems, including a critical comparison with analytical and other methods. Literature surveys and written and oral presentation of results will be emphasized. 4 credits.

707. Analytical Fluid Dynamics

An analytical study of the dynamic behavior of fluids. Topics include potential flow, development of the Navier-Stokes equations, turbulence, and boundary layer theory. 4 credits.

708. Gas Dynamics

Basic equations of motion of one-dimensional, subsonic and supersonic flows of compressible, ideal fluids. Wave phenomena. Rankine-Hugoniot relations. Linear approach to two-dimensional flow problems. 4 credits.

Mechanical Engineering

715. Internal Combustion Engines

Application of basic and engineering science to the engineering problems of spark and compression ignition engines: design, management, and reporting of experimental studies. 4 credits.

716. Propulsion Systems

Application of basic and engineering sciences to the engineering problems of propulsion systems. 4 credits.

723. Advanced Dynamics

A traditional course in classical mechanics with an orientation to contemporary engineering applications. Review of particle dynamics, Hamilton's principle and the Lagrange equations. Kinematics and dynamics of rigid bodies, gyroscopic effects in machinery and space structures. 4 credits.

724. Introduction to Vibrations

The theory of discrete vibrating systems is treated in depth. Review of linear system concepts and detailed treatment of the single degree of freedom system with general excitation. Matrix theory and eigen-value problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods. Introduction to continuous systems. Applications are made both to structural and mechanical systems. 4 credits.

726. Experimental Mechanics

Experimental methods and their underlying theoretical bases are developed and applied to the measurement of stress, strain, and motion. 4 credits.

727. Advanced Mechanics of Solids

Advanced topics in the mechanics of solids are treated in depth; beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 credits.

730. Mechanical Behavior of Materials

The elastic and inelastic behavior of materials, both organic and inorganic, is studied from a point of view of micromechanics and macromechanics. Concepts of stress, strain, and constitutive relations are reviewed and related to recent developments in dislocation theory and other phenomena on the atomic scale and to continuum mechanics on the macroscopic scale. Mechanical behavior including elasticity, plasticity, viscoelasticity, creep, fracture, and damping will be treated. Anisotropic and heterogeneous materials such as composite materials will be studied in detail. 4 credits.

741. Control of Physical Systems

Theory and methods for modeling and evaluating fluidic, hydraulic, and pneumatic control systems. 4 credits.

742. Discontinuous Control

The analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods which use the quantized nature of the information are also developed. 4 credits.

751. Naval Architecture

Hydrodynamic resistances of surface ships and submerged bodies; model testing theory; powering and propellers; use of Standard Series tests; introduction to ship motion, control steering, and rudders; concepts of ship design; computer application to problems. 4 credits.

761. Crystalline Solids

Theoretical and experimental studies of the structure of crystalline solids using X-ray diffraction techniques. 4 credits.

763. Microstructure of Solids

Theoretical and experimental studies of the microstructure of solids using optical and electron microscopy. 4 credits.

781. Mathematical Methods in Engineering Science I

Mathematical methods in engineering sciences are discussed, including methods for solution of discrete and continuous systems. Course includes a review of calculus, linear algebra, complex numbers, Fourier series, differential and partial differential equations with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 credits.

793 a-d and 794 a-d. Special Topics in Engineering

Course numbers refer to topics in thermodynamics, mechanics, engineering design, and materials respectively. Content of these courses may vary from year to year. 2-4 credits.

795 a-d. Independent Study; 2-4 credits.

796 a-d. Independent Study; 2-4 credits.

801. Irreversible Thermodynamics

Non-equilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prerequisite: Mechanical Engineering 701. 4 credits.

803. Conduction Heat Transfer

Heat conduction equation; temperature fields and the heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 4 credits.

804. Radiation Heat Transfer

The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories. Methods of solution of radiant interchange in real systems with and without absorbing media. 4 credits.

806. Convection Heat Transfer

An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 credits.

Mechanical Engineering

807. Compressible Fluid Flow

General equations of motion for real and ideal compressible fluid flow including boundary layer equations; methods of solution. Prerequisite: Mechanical Engineering 751 or 736, Mathematics 630. 4 credits.

808. Theoretical Aero/Hydro-Mechanics

The mathematical development of the equations of frictionless fluid flow using both tensor notation and various coordinate systems. Conformal mapping; Blasius Theorem; Joukowski Hypothesis; flow around airfoils, Schwartz Christoffel theorem and vortex motion. 4 credits.

822. Continuum Mechanics

Conservation laws for gases, liquids, and solids in a continuum are developed starting from Liouville and Boltzmann equations. Passage from a discrete system to a continuum is discussed. Constitutive equations for viscoelastic, thermoelastic, and non-linear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases and biomechanics. Introduction to phenomenological Lagrangian theories. 4 credits.

824. Vibrations of Continuous Media

Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 credits.

826. Theory of Elasticity

The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions, elastodynamic fields, inhomogeneous, anisotropic wave equations; wave propagation and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 credits.

827. Theory of Plasticity

Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 credits.

829. Theory of Plates and Shells

Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 credits.

860. Physical Metallurgy

Introduction to the electron theory of materials; entropy and free energy concepts of the solid state; diffusion in metals; nature and kinetics of selected solid-state reactions. 4 credits.

866. Physical Ceramics

Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation, crystal growth, and solid-state reactions; kinetics of grain growth, sintering, and vitrification. 4 credits.

882. Mathematical Methods in Engineering Science II

This course is a continuation of ME 781 which is a prerequisite. Topics treated include complex variable techniques, integral transform techniques for the solution of differential and partial differential equations, Green's functions, Wiener-Hopf techniques, variational techniques. Stochastic problems with application to random vibration, statistical control theory, turbulence, heat conduction and fluctuation phenomena in solids, transport theory, gases, and liquids. Topics may vary from year to year. 4 credits.

883. Tensor Analysis and Differential Geometry

Mathematical groundwork for applied group theory, transformation groups, affine groups and affine geometry. Coordinate transformations and point transformations. Affinors, tensors, and their algebraic properties. Invariant differential operators. Lie derivative, holonomic and anholonomic coordinate systems. Curvature tensor, Bianchi identity, tensor densities. Green's theorem, Green's functions, potential functions. Pfaff's problem. 4 credits.

890 a-d and 891 a-d. Special Topics in Engineering

Course numbers refer to topics in thermodynamics, mechanics, engineering design, and materials respectively. Content of these courses may vary from year to year. 2-4 credits.

892. Master's Project

The student will work with a faculty member on a well defined research and/or design problems. A written report and seminar will be presented. 4 credits.

895 a-d and 896 a-d. Graduate Independent Study

Investigation of graduate level problems or areas germane to mechanical engineering. 1-4 credits.

899. Master's Thesis

6-10 credits.

For additional courses, see listing under Technology, page 146.

Microbiology (47)

Chairman: *Lawrence W. Slanetz*

PROFESSORS: William R. Chesbro, Galen E. Jones, Theodore G. Metcalf, Lawrence W. Slanetz

ASSISTANT PROFESSOR: Fred T. Hickson

Students admitted to graduate study in Microbiology are expected to have had adequate preparation in the biological and physical sciences and in the basic courses

Microbiology

in Microbiology. The candidate for the Master of Science degree will be required to complete a thesis and pass an examination covering his graduate courses and thesis.

Candidates for the Doctor of Philosophy degree must demonstrate proficiency in reading microbiological literature in two foreign languages, usually French and German, must demonstrate to the doctoral committee a broad, basic knowledge of the field of Microbiology, and must complete a dissertation on some original research in Microbiology.

701. Advanced Microbiology

The growth, nutrition, and metabolism of microorganisms; consideration of cell structure and localization of function; aspects of genetic and nongenetic regulation of metabolism; study of the influences of chemical and physical factors of the environment upon microorganisms. Mr. Chesbro. Prerequisite: Microbiology 503. 2 lectures; 1 laboratory; 4 credits.

702. Pathogenic Microbiology

The morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Mr. Metcalf. Prerequisite: Microbiology 503. 2 lectures; 2 laboratories; 4 credits.

705. Immunology and Serology

The defensive elements possessed by man and animals which serve to protect them from infectious microorganisms. The principles of serological techniques used in the recognition and identification of biological materials including microorganisms. The preparation of vaccines and the production of antisera in animals. Mr. Metcalf. Prerequisite: Microbiology 702. 2 lectures; 2 laboratories; 4 credits.

706. Virology

The animal and plant viruses, including bacteriophages and the rickettsiae; a consideration of techniques for the propagation and recognition of animal viruses; the interactions between virus and host cell; and the application to problems of plant or animal infections caused by viruses. Mr. Metcalf. Prerequisite: Microbiology 702. 1 lecture; 3 laboratories; 4 credits.

707. Marine Microbiology

Characterization of microbes in the sea as to taxonomy, physiology, ecology, and transformations of carbon, nitrogen, sulfur, and phosphorus; methods of sampling and enumeration; biogeochemistry; properties of sea water and the marine environment. Parallels to soil microbiology will be drawn. Mr. Jones. Prerequisite: Microbiology 503 and Biochemistry 751. 2 lectures; 1 laboratory; 4 credits.

795, 796. Problems in Microbiology

Special problems, depending upon the training and desire of the student. Elective only upon consultation. Staff. Credits to be arranged.

800. Systematic Bacteriology

Procedures and methods for the classification of bacteria; review of modern systems of classification. Mr. Slanetz. Prerequisite: one year of microbiology. 2 lectures; 1 laboratory; 3 credits.

802. Microbial Physiology

Microbial physiology is the study of the means by which microorganisms survive. It deals with the effects of nutritional, chemical, and physical factors on microbial growth, the generation of activated metabolites during catabolism; and the use of these metabolites for the synthesis of macromolecules, the nongenetic mechanisms directing and regulating cellular metabolism; the biochemical cytology of the microbial cell; and with evolutionary and ecological relationships among microbial species. Mr. Chesbro. Prerequisite: a course in general biochemistry (may *not* be taken concurrently) and Microbiology 503. 2 lectures; 2 laboratories; 4 credits.

803. Microbial Cytology

The fine structure of bacteria and related organisms. (Procaryotic Protists). Application of current techniques for the demonstration and isolation of external appendages, cell walls, cytoplasmic membrane, protoplasts, inclusions, and chromatin bodies. Prerequisite: Microbiology 701. 2 lectures; 2 laboratories; 4 credits.

804. Microbial Genetics

An introduction to genetic principles and methodology applicable to microorganisms; fine structure of genetic material, mutation, selection, adaptation, recombination, transformation, and transduction. Mr. Hickson. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

897-898. Microbiology Seminar

Reports and discussions on microbiological literature and recent developments in microbiology. Staff. Prerequisite: permission of instructor. 1 credit.

899. Master's Thesis

6-10 credits.

999. Doctoral Research

Music (63) (64)

Chairman: *Keith Polk*

PROFESSORS: Karl H. Bratton, Donald E. Steele

ASSOCIATE PROFESSORS: Alan Grishman, Peter Waring, John B. Whitlock, John D. Wicks

ASSISTANT PROFESSORS: Stanley D. Hettinger, Wendell E. Orr, Keith Polk

The Department of Music offers programs leading to the degrees of Master of Arts in Music and Master of Science in Music Education.

Master of Arts in Music

Admission to this program depends upon a Bachelor of Arts degree in Music or its equivalent from an accredited institution. Placement examinations in music theory, music history, and in piano are administered by the Department of Music. Students not meeting standards in these phases of achievement will be required to

Music

take undergraduate courses to meet their deficiencies. A reading test in German is also required.

In studies for the degree, concentration is in the field of music history and music theory. The degree is not organized as a terminal degree in itself, but does prepare a student for work at the doctorate level. The content of the degree emphasizes the disciplines of bibliography, research, the writing of papers, analytical studies of music literature, readings in source material, and advanced theory. The following courses are required: Music 855, 856, 857, 858, 891, 892, 893. The remainder of the courses may be drawn from the 700 series in Music or the 600, 700, and 800 series in other departments, with the permission of the adviser. Sufficient electives are required to total 30 credits.

Master of Science in Music Education

Admission to this program depends upon an appropriate Bachelor's Degree in Music Education or its equivalent from an accredited college. A placement examination is administered by the Department of Music. Deficiencies must be made up.

The goal of this degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, theory, and independent study. Each candidate will be required to complete one of the following: a professional paper; a field of study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; or the preparation and conducting of a major work in public performance for band, orchestra, or choir. The following courses must be taken: Music 855, 893, Music Education 796, 883 or 884. Also required are 6 credits in the Department of Education from courses such as the following: Education 820, 855, 858, 865, 883, 886, 892, and the 700 courses. Vocal or instrumental study at the 800 level is required to a minimum of 4 credits. A maximum of 9 credits is allowed if the graduate recital option is elected. Sufficient electives are required to total 30 credits.

Music (63)

701. Music of the Medieval Period

Periods considered include plainsong, music of the Mass, secular monophony, beginnings of polyphony. French, and Italian Ars Nova. 4 credits.

703. Music of the Renaissance

Important composers of the fifteenth and sixteenth centuries and their works: Vittoria, Palestrina, Byrd, and others. 4 credits.

705. Music of the Baroque

Early, middle, and late baroque music and its various schools. The cantatas, lute and keyboard music, the early concerto, and sonata are studied in detail. The literature of Bach and Handel is investigated. 4 credits.

707. Music of the Classical Period

The music of the rococo and classical periods. The following subjects will be investigated: "style galant," opera seria and opera buffa, the keyboard sonata, and the music of Haydn and Mozart. 4 credits.

709. Music of the Romantic Period

The sonata form as a basis for the symphonies, concerti, chamber music, and keyboard works of Beethoven, Berlioz, Schubert, Mendelssohn, Schumann,

Brahms, Franck, Chopin, and Liszt. Romantic elements contained in the development of harmony orchestration, sonority, expressive content. The rise of the short piano piece, the German art song, the symphonic poem, nationalism in music. 4 credits.

711. Music of the Twentieth Century

Music of the twentieth century, including its literature, its trends, and an analysis of techniques, styles, forms, and expression. 4 credits.

721. The Life and Works of Beethoven

The piano sonatas, symphonic works, and the string quartets. Lectures, analysis, reports, required readings, and listening. 4 credits.

731. The Lied

Study of the history and literature of the German art-song, with special emphasis on the 19th and early 20th century. Prerequisite: permission of the instructor. 4 credits.

732. The Art Song

Study of the history and literature of non-German Art Song. Prerequisite: permission of the instructor. 2 credits.

733, 734. Survey of Opera and Oratorio

A historical and musical survey of the opera and oratorio from their common birth, through the development of each specific form to the present day. Particular stress is given to political and religious influences. 4 credits.

735, 736. Survey of Pianoforte Literature

The history and development of keyboard literature from Bach to the present. A discussion and performance of the works of Bach, the sonatas and concertos of Haydn, Mozart, Beethoven, Schubert, the Romantic composers, and of contemporary writers. 4 credits.

755, (755). Performance Studies in Medieval Music

The courses in ensemble performance studies are for advanced undergraduate and graduate student performers. These courses will call for more complex techniques than those attempted in the usual chamber music literature. A Renaissance section, for instance, would investigate the improvisational practices of the fifteenth and sixteenth centuries. A Baroque section would delve into ornamentation. A Contemporary section might attempt one of the extraordinarily complicated contemporary scores, or even try improvisation. Mr. Polk. 2 or 4 credits.

756, (756). Performance Studies in Renaissance Music

See 755 for course description. Dr. Polk. 2 or 4 credits.

757, (757). Performance Studies in Baroque Music

See 755 for course description. Miss Rasmussen. 2 or 4 credits.

758, (758). Performance Studies in Classical Music

See 755 for course description. Mr. Grishman. 2 or 4 credits.

Music

759, (759). Performance Studies in Romantic Music

See 755 for course description. Mr. Grishman, Mr. Steele. 2 or 4 credits.

760, (760). Performance Studies in Twentieth Century Music

See 755 for course description. Mr. Rogers. 2 or 4 credits.

771, 772. Counterpoint

First semester: Sixteenth century polyphony based on the style of Palestrina. Second semester: free instrumental counterpoint based on the styles of Bach and Handel. Twentieth century counterpoint will be discussed in the closing classes of the course. Prerequisite: Music 523-524 or permission of instructor. 2 credits.

773. Canon and Fugue

Free counterpoint in three and four parts, double counterpoint, the writing of simple two-part inventions, choral preludes, etc. The canonic and fugal studies will be based largely upon the works of Bach and will have as their objective the composition of a two-, a three-, and a four-voiced fugue. Prerequisite: Music 719-720 or permission of instructor. 2 credits.

775-776. Composition

The various smaller harmonic forms, the variation, the rondo, and the sonata forms will serve as models for composition. Prerequisite: permission of instructor. 2 credits.

777-778. Advanced Composition

This course will cover material ranging from strict composition in the "traditional forms" to free composition in "contemporary forms." Exactly what is to be stressed will depend on the makeup of the class. Work will be done on an individual and group basis. 4 credits.

779. Orchestration

Instruments and methods of combining them into coherent arrangements arriving at successful balances for the band and orchestral arranger. The characteristics, range, and tone quality of the instruments are fully covered and transcriptions are made. Orchestral effects are studied. Choroestration is offered during the latter part of the second semester. The techniques of writing for solo voices, for mixed voices, men's, and women's voices are taken up through the medium of arrangements and original work. Prerequisite: permission of instructor. 4 credits.

781. Form and Analysis

A consideration of various formal and textural elements as concepts and within the context of musical examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Prerequisite: Music 523-524. 4 credits.

795. Special Studies in Music Literature

This course will be similar in subject matter to Music 595, but presumes greater technical background allowing the individual student to operate more independently and in greater depth. 4 credits.

817, (817). Applied Music for Graduate Credit

(1) Piano; (2) Organ; (3) Violin, Viola; (4) Violoncello; (5) Voice; (6) Woodwind; (7) Brass; (8) Percussion. Further development of technique, music interpretation, and repertory. Emphasis may also be directed toward the functional use of the instrument in the schoolroom. Prerequisite: must exhibit sufficient proficiency to warrant graduate study and permission of Department Chairman and the student's graduate supervisor. Audition required. A student may register for credit in the same courses in successive years with the approval of his major professor. Music staff. 1-2 credits.

855. Introduction to Bibliography

The student will become familiar with the reference materials of music, dictionaries, journals, and periodicals, and with major monographs and editions. 3 credits.

856. Readings in Music History: Antiquity to 1600

An opportunity to read and study in detail a restricted number of monographs and editions. 3 credits.

857. Readings in Music History: 1600-1820

An opportunity to read and study in detail a restricted number of monographs and editions. 3 credits.

858. Readings in Music History: 1820 to the Present

An opportunity to read and study in detail a restricted number of monographs and editions. 3 credits.

891, 892. Research Seminar

Guidance in individual research projects. Permission of instructor. 3 credits.

893. Theory Seminar

Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to Monteverdi. Permission of instructor. 3 credits.

894. Theory Seminar

Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. 3 credits.

Music Education (64)**741-742. Techniques and Methods in Choral Music**

A lecture-workshop course touching upon some of the problems and solutions in the organization and performance of high school and college glee clubs and community choirs. Emphasis is placed on techniques of choral conducting and rehearsal, repertory, and materials. Offered to Music Education students who wish to place a greater emphasis on a vocal option in the curriculum rather than instrumental. A student taking 751, 752 may substitute them for two of the instrumental techniques and methods courses. 2 credits.

743. Materials and Methods in Piano Music

This course in the methodology and materials of beginning piano instruction is designed to give all potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent. This course

Music

should also be available for the Music Education students who are not basically pianists, but who are often called upon to give piano instruction. 2 credits.

745, 746. Techniques and Methods in String Instruments
2 credits.

747, 748. Techniques and Methods in Woodwind Instruments
2 credits.

749, 750. Techniques and Methods in Brass Instruments
2 credits.

751. Techniques and Methods in Percussion Instruments
2 credits.

785. Music for the Elementary Classroom Teacher

For the non-music specialist interested in utilizing music as a means of enriching children's lives. The correlation and integration of music in the school curriculum and the basic skills and techniques necessary. Also open to music specialists and school administrators. Mr. Whitlock. 4 credits (Summer Session course.)

787. Problems in the Teaching of School Music

Aims, scope, and organization of materials and activities in the elementary schools in keeping with modern trends in educational philosophy. The child voice, its care, and development. A demonstration of materials and methods for the various grades. Observations of elementary school music. Prerequisite: Education 758. 3 lectures; 1 laboratory; 2 credits.

791. The Teaching of School Music

The application of educational principles to the teaching and learning of music, and the organization of the music curriculum on the junior and senior high-school levels. The adolescent voice and the classification of voices; the selection of vocal and instrumental materials to fit the needs of the individual group, in order to insure the maximum growth and musical development of the students; and the building of unified concert programs. Problems of administration and management, and the relationship of the teacher to school and community. Observation of music programs in secondary schools. Prerequisite: Education 758. 3 lectures; 1 laboratory; 4 credits.

883. Instrumental Literature and Its Performance

Exploration of representative solo and ensemble music for string, wind, and percussion instruments. Typical literature from each period of music is studied. As much as is possible, live performance is included, recordings used as required. Detailed attention given to interpretation. Project required. 3 credits.

884. Choral Literature and Its Performance

Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students will have opportunities to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college choral repertoires. 3 credits.

Physics (86)

Chairman: *Robert E. Houston Jr.*

PROFESSORS: Edward L. Chupp, Harry H. Hall, Robert E. Houston Jr., John A. Lockwood, Robert H. Lambert, Lyman Mower, John E. Mulhern Jr., William R. Weber

ASSOCIATE PROFESSORS: David G. Clark, Richard L. Kaufmann

ASSISTANT PROFESSORS: Roger L. Arnoldy, L. Christian Balling, John F. Dawson, John Dowling Jr., Mark P. Klein, George H. Mullen, Robert E. Simpson

The Physics Department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy. Graduate students entering in the Master of Science and Doctor of Philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that of the senior year in physics at the University of New Hampshire. To assist in starting a student's work at the proper level, a placement examination is required of all entering graduate students. This examination will be offered prior to the fall registration period.

Master of Science for Teachers

The degree of Master of Science for Teachers is offered for candidates who satisfy the general admission requirements (see page 19) or who hold a secondary school teacher certification in physics or in general physical science. The course leading to this degree will normally be chosen so as to improve the candidate's ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics. Persons interested in this degree should confer with the Department Chairman or the graduate adviser.

Master of Science Degree

For admission to graduate study in physics leading to a Master of Science Degree, the student should have completed 24 to 30 semester hours of undergraduate courses in physics. Suitable undergraduate preparation in mathematics is essential to graduate study in physics and should include differential equations, linear algebra, and advanced calculus. Candidates for admission are also required to take the Graduate Record Examination (both the aptitude test as well as the advanced test in physics). The results of this examination will be used in conjunction with transcripts to evaluate the applicant's undergraduate training. The courses required for a Master of Science degree include Physics 833, 839, 841, and 843. Candidates may select one of the following two options:

a) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.

b) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of 6 semester hours work, and pass an oral examination on the thesis.

Doctor of Philosophy Degree

For admission to graduate study in physics leading to a Doctor of Philosophy degree, the student should satisfy the same general admission requirements as for a Master of Science Degree. In addition, he is expected to demonstrate an outstanding proficiency in undergraduate physics. Candidates for the degree must pass the

Physics

placement examination with distinction within one year of enrollment. Admission to candidacy for the degree is based on demonstrated ability in formal course work, satisfaction of the language requirement, and passing a written and oral qualifying examination based on courses in the graduate physics curriculum. For students entering with a Master's degree, the qualifying examination must be taken within one year of enrollment; for students entering with a Bachelor's degree, the qualifying examination must be taken within two years of enrollment. Students are allowed two attempts to pass the qualifying examination. Finally, upon completion of a thesis, the doctoral candidates will take an oral examination based on his area of research.

The courses required for a Doctor of Philosophy degree consists of 831, 833, 839, 841-842, 843-844, and five courses selected as follows:

a) Two courses from any *one* of the following areas:

Area 1 835-836 Statistical Mechanics

Area 2 861-862 Quantum Mechanics

Area 3 863-864 Nuclear Physics

Area 4 865-866 Solid State Physics

Area 5 850, 852 Plasma Physics

b) Three additional courses chosen from the above list of areas.

The language requirement consists of demonstrating a reading ability in one of the following foreign languages: German, French, or Russian. This requirement may be satisfied by any one of the following methods:

a) Satisfactory performance on the Educational Testing Service foreign language examination.

b) Satisfactory performance on the reading examination administered by the Department.

c) *After* two attempts at either a) or b), the requirement may be satisfied only by the completion of a one-year course in the language.

Chemical Physics Option

Doctor of Philosophy candidates in physics may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Chemistry. In this option the doctoral student, with the advice of his guidance committee, elects courses in physics and chemistry (or, in some cases, mathematics), writes his dissertation on a research problem (experimental, theoretical, or both) appropriate to interdisciplinary treatment, and receives the doctorate in either physics or chemistry. In addition, each candidate must satisfy certain other requirements of the department in which the degree is granted. Ordinarily, students choosing the chemical physics option are expected to have undergraduate degrees in physics, chemistry, or mathematics and reasonably strong backgrounds in the other two disciplines.

607. Physical Optics

Maxwell's equations, the nature of light, interference, diffraction, polarization, and related phenomena. (Offered on request.) Prerequisite: Mathematics 527. 3 credits.

701. Introductory Quantum Mechanics

Quantum mechanics with application to atomic physics. Prerequisite: Physics 503 and 704. 4 credits.

702. Atomic and Nuclear Physics

Magnetic moments, spin, identical particles, multielectron atoms, collision theory, and the nucleus. Prerequisite: Physics 701. 4 credits.

703-704. Electricity and Magnetism

Foundation of electromagnetic theory, including electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents. Maxwell's field theory, and an introduction to electrodynamics. 4 credits.

831-832. Mathematical Physics

Differential equations of physics, complex variables, orthogonal functions, variational methods, matrices, vector, and tensor analysis. 3 credits.

833-834. Experimental Physics

Modern research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear, atomic, and molecular phenomenon. 1-3 credits.

835. Statistical Physics I

A review of thermodynamics and kinetic theory, followed by an introduction to statistical thermodynamics. Prerequisite: Physics 831 or permission of instructor. 3 credits.

836. Statistical Physics II

Basic formulation and application of statistical mechanics to physical problems. (Offered on request.) Prerequisite: Physics 844. 3 credits.

837. Mathematical Physics

Formulation and solution of physical problems grouped according to their mathematical properties. (Offered on request.) Prerequisite: Physics 831-832. 3 credits.

839. Theoretical Mechanics

Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 credits.

841-842. Electromagnetic Theory

The formulation and detailed application of electromagnetic theory to physical problems. Prerequisite: permission of instructor. 3 credits.

843-844. Quantum Mechanics

Wave mechanical and Dirac formulations of non-relativistic quantum mechanics. Prerequisite: Physics 701, 839. 3 credits.

850. Plasma Physics I (Hydromagnetic Phenomena)

Steady state conditions, hydromagnetic waves, turbulence, shock waves, and individual particle motion will be discussed. 3 credits.

852. Plasma Physics II

A description of Plasma Physics from the Kinetic Theory point of view. (Offered on request.) Prerequisite: Physics 835. 3 credits.

Plant Science

861-862. Advanced Quantum Mechanics

Generalized formulation of quantum mechanics, formal scattering theory and introduction to relativistic theory. Field theory, and related topics. Prerequisite: Physics 839 and 844. 3 credits.

863-864. Nuclear Physics

Formulation of theory underlying current experiments. Prerequisite: Physics 843. 3 credits.

865-866. Solid State Physics

Development of quantum mechanical theory of solids, transport, phenomena, etc. (Offered on request.) Prerequisite: Physics 843 and 835. 3 credits.

887. Introduction to Space Science

Detailed study of the earth and its physical environment, interplanetary medium, magnetosphere, the solar system, and beyond. Prerequisite: permission of instructor. 3 credits.

889-890. Space Physics Seminar

Lectures and discussions of current research in the physics of fields and particles in space. 1-3 credits.

891, 892. Problems in Theoretical Physics

May be taken more than once. (Offered on request.) 3 credits.

893, 894. Problems in Experimental Physics

May be taken more than once. (Offered on request.) 3 credits.

895, 896. Special Topics

Any special fields of study not covered by the above courses may be included. Choice of topic to be determined by class. May be taken more than once. 1-3 credits.

897-898. Colloquium

Required of all graduate students. Topics to be selected. No credit.

899. Master's Thesis

6 credits.

999. Doctoral Research

Plant Science (32)

Chairman: *Lincoln C. Peirce*

PROFESSORS: Gerald M. Dunn, Russell Eggert, C. A. Langer, Lincoln C. Peirce

ASSOCIATE PROFESSORS: Lorne A. McFadden, Owen M. Rogers, Douglas G. Routley

ASSISTANT PROFESSORS: J. Brent Loy, Otho S. Wells

The graduate research program in Plant Science is concerned with solving basic and applied problems associated with production of horticultural or agronomic

crops. Facilities include laboratories, field and greenhouse research areas, and plant growth chambers.

Program emphasis is directed toward breeding and genetics and toward crop physiology or biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding is a major strength and is complemented by expanding University programs in statistics and genetics. (See description of Genetics Program.) Increased emphasis also is being given to research in plant physiology and plant biochemistry. In certain instances these research areas are integrated with the genetics projects to provide unique approaches toward solving fundamental problems.

It is recommended that all graduate students first complete work for the Master of Science degree. Candidates for this degree will be required to pass an oral examination and will be required to prepare a thesis. Candidates for the Doctor of Philosophy degree, in addition to the general requirements, must also demonstrate proficiency in a language approved by the major department. This requirement may be satisfied during graduate study or upon entering graduate school either by presenting 8 college semester credits with each course grade no less than B, or by passing a language examination approved by the Department. In general, German, French, Spanish, and Russian are considered acceptable for American students. Foreign students whose native language is not English will satisfy the language requirement by passing a qualifying English examination administered by the Department. A thesis on original research in the student's area of specialization is required for the doctoral degree.

708. Plant Nutrition

Mineral nutrient requirements of plants, nutrient availability in soils and fertilizers; effects of environment on nutrient uptake, translocation, on differentiation of plant parts, and on hardiness. Interrelationships between plant-nutrient elements and effects of one element on absorption and translocation of others. Soil and tissue tests for mineral elements. Prerequisite: Plant Anatomy or Plant Physiology, Organic Soils. Mr. Eggert. 3 lectures; 1 laboratory; 4 credits.

710-711. Advanced Topics in Plant Science

A flexible course structure permitting independent study or group discussion of advanced technical or scientific topics. 2 or 4 credits. Students should consult with appropriate course coordinator before registering.

- | | |
|----------------------------------|-------------------------------|
| R-1 Physiology — Mr. Estes | R-5 Fruit Crops — Mr. Eggert |
| R-2 Genetics — Mr. Dunn | R-6 Field Crops — Mr. Higgins |
| R-3 Ornamentals — Mr. Rogers | R-7 Turfgrass — Mr. Higgins |
| R-4 Vegetable Crops — Mr. Peirce | |

762. Plant Metabolism

The function, occurrence, synthesis, and degradation of plant constituents. Major emphasis is placed on respiration and photosynthesis and their relationships to the metabolism of lipids and nitrogen compounds. Prerequisite: Biochemistry. Mr. Routley. Laboratory optional. 2 or 4 credits.

769. Plant Growth Regulators

Study of hormones and plant growth substances; relationships to differentiation and development of plant tissues. Prerequisite: Plant Physiology, Biochemistry. Mr. Routley. Laboratory optional. 2 or 4 credits. (Alternate years; offered fall 1971.)

Political Science

773. Methods and Theory of Plant Breeding

Theory and use of plant breeding systems with emphasis on improving quantitative traits. Prerequisite: Genetics, Statistics. Mr. Peirce. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered fall 1970.)

832. Development Genetics

Relation of protein, RNA, and DNA synthesis to development, chromosome differentiation, nuclear-cytoplasmic interactions, genic and non-genic control of subcellular organization, cellular continuity, cell associations, experimental embryology, hormones and post-embryonic development, and neoplastic growth. Prerequisite: permission of instructor. Mr. Loy. 3 credits (Alternate years; offered spring 1971.)

851. Plant Genetics

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 credits. (Alternate years; offered fall 1969.)

853. Cytogenetics

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Mr. Rogers. Prerequisite: Genetics, Cytology. 2 lectures; 1 laboratory; 3 credits. (Alternate years; offered fall 1970.)

895-896. Research in Plant Science

Advanced investigations in a research subject, exclusive of thesis. Staff. 1-4 credits.

897-898. Graduate Seminar

Library research and discussion of current topics of Plant Science. Required of all graduate students majoring in Plant Science. Staff. 1 credit.

899. M. S. Thesis

A thesis requiring study in depth of a phase of Plant Science. Required of all M.S. candidates in Plant Science. 6-10 credits.

999. Doctor of Philosophy Thesis

Dissertation reflecting independent research in a phase of Plant Science is required. Credit received upon completion.

Political Science (52)

Chairman: *George K. Romoser*

PROFESSORS: Robert B. Dishman, John T. Holden

ASSOCIATE PROFESSORS: Erwin A. Jaffe, David L. Larson, George K. Romoser, Peter Savage, John Woodruff, Frederic Wurzburg

ASSISTANT PROFESSOR: Lawrence W. O'Connell

A candidate for admission to graduate study in the Department of Political Science is normally expected to have majored in Political Science or a closely related field as an undergraduate, and to have achieved an academic record of some

distinction. In exceptional cases, however, the Department will waive this requirement, provided the candidate will follow without credit a program of study agreed upon by the student and the departmental adviser and Chairman. This waiver is usually reserved for the unusual student.

The Department offers the Master of Arts in Political Science and the Master of Public Administration. The candidate in each of these programs is expected to complete eight full courses of four credits each, for a total of thirty-two credits. Of these eight courses, it is recommended that two courses be taken in a related discipline, and more may be taken outside the Department with the approval of the adviser and the Chairman. It is also expected that the candidate will develop an area of concentration among the fields offered by the Department: American Politics, Comparative Politics, International Relations, Political Thought, and Public Administration. The student is required to take Political Science 399, Directed Research and Study, in which he will write a research paper in his major field of interest. Where it is necessary to his program of study and research, the student must demonstrate capability in the relevant foreign language, or capability in the tools of quantitative analysis.

To receive a master of Public Administration degree a candidate must complete eight full courses of four credits each, for a total of thirty-two credits. Of these eight courses, four will deal with the administrative process, two will be in statistics and research in government problems, and the remainder will be selected to suit the particular interests of the candidate. The degree is designed for individuals intending to pursue an administrative career. Candidates are expected to serve an internship for which they receive academic credit.

Candidates for advanced degrees are expected to take courses at 700-800 levels in Political Science and related disciplines, and to maintain a passing grade (P) in all courses.

715, 815. Comparative Politics

The political dynamics and institutions in developed and under-developed areas are analyzed by comparative method. Mr. Wurzburg. 4 credits.

717, 817. Continental European Political Parties

Theories of representation and political parties are related to historical circumstance. Changes within and among political parties are connected with the changing role that parties play in the political process. Mr. Wurzburg. Prerequisite: permission of instructor. 4 credits.

726, 826. Pressure Groups and the Government Process

Political interest groups are analyzed as an integral, if unofficial, part of the American political system in their efforts to influence public officials by lobbying, propaganda, and direct political action. Prerequisite: Political Science 406. 4 credits.

727, 827. The American Political Executive

The behavior of the American President and other political executives in the formulation and execution of policy. The role of public opinion, groups, and voting behavior in executive, political leadership and power, and the political executive in democratic political systems in modern times and prospects for the future. Mr. Dishman. 4 credits.

Political Science

728, 828. Legislative Behavior and the United States Congress

The role of Congress and legislative behavior in the American political system, including the organization, operation, and process of legislating, and the personnel and informal rules of the legislative process. The influence of groups, public opinion, elections, and decision-making agencies on the legislative policy-making process and the analysis of proposed reforms of legislatures, including the functions of legislative policy-making in democratic, political systems. 4 credits.

731, 831. The Administrative Process

The principal concepts of governmental administration, including theories of organization, administrative leadership, internal management, and administrative responsibility and control. The relationship of group behavior and policy development to the administrative process. Mr. O'Connell and Mr. Savage. Prerequisite: Political Science 406 or Sociology 400. 4 credits.

732, 832. Comparative Administration

An examination of the structure, conceptual foundations, and dynamics of administrative systems in major countries. Mr. Savage. 4 credits.

736, 836. Urban Government and Politics

An analysis of the role of government in planning and managing the problems of the urban community. Metropolitan planning will be treated in relation to zoning, land use, open space preservation, and transportation. The administrative functions to be studied include welfare, health, urban renewal, and police protection. Mr. O'Connell. 4 credits.

741, 841. Administration of Justice

A comparative study from primitive times to the present of the administration of criminal and civil justice under various legal systems. The modern role of the police, public prosecutor, judge, jury, counsel, and interest groups in the judicial process in the United States and in other nations, including England and Wales, France, Germany, and the Soviet Union. Mr. Dishman. 4 credits.

742, 842. The Supreme Court and the American Constitution

The Supreme Court considered as both a court of law and a political institution. The origins and development of judicial review and changing conceptions of the judicial process. The Supreme Court as supreme arbitrator in disputes between the nation and the states, the President and Congress, and majority rule and minority rights. Mr. Dishman. Prerequisite: Political Science 406 or permission of instructor. 4 credits.

745, 845. World Politics

The basic driving forces in international relations, including the nature of political power and its extension or limitations. Geopolitics, nationalism, ideology, imperialism, international economic relations, balance of power, warfare, regulation of arms, international law, and collective security. Mr. Holden. 4 credits.

746, 846. Foreign Policies of the Great Powers

Fundamental factors influencing contemporary foreign policy formulation in the United States, the Soviet Union, the British Commonwealth, and other significant powers. Problems and choices confronting policy makers of these

powers in dealing with issues involving the United Nations, regional organizations, Western Europe, Middle East, and Asia. Mr. Holden. 4 credits.

747, 847. Conduct of Foreign Policy

The constitutional, institutional, and procedural aspects of decision-making within the framework of U. S. national security and national policy. Some emphasis will be given to the ideological framework within which the decision-making process occurs. Mr. Larson. 4 credits.

751, 851. Contemporary Southeast Asia

A comparative study of the political and social development of Southeast Asia. The significance of the role of independence and dependence; the competing influence of communism and Western democracy; the special significance of the role of China, India, Great Britain, and the United States. The states to be studied include the Philippines, Laos, Cambodia, Vietnam, Thailand, Burma, Malaysia, and Indonesia. Mr. Holden. 4 credits.

752, 852. Governments of Emerging Countries

A comparative study of recent developments in the politics and governing systems of Asia and Africa, and regional arrangements indigenous to these areas. Mr. Savage. Prerequisite: Political Science 405 or permission of instructor. 4 credits.

754, 854. Governments of Latin America

A comparative study of the politics and government systems of Latin America with some consideration given to regional arrangements. Mr. Larson. Prerequisite: Political Science 405 or permission of instructor. 4 credits.

756, 856. Contemporary South Asia

A comparative and analytical study of the historical, political, social, and economic influences in modern South Asia. Special attention will be paid to the rivalries between Pakistan and India, to the pressures of the Soviet Union, the United States, and China; to the influences of both the Commonwealth and the Afro-Asian-bloc ideals and goals. The states to be included are Pakistan, India, Ceylon, Nepal, and Afghanistan. Mr. Holden. 4 credits.

757, 857. Government and Politics of China

An analysis of the political, economic, and cultural institutions of contemporary China and of the circumstances and ideologies which contributed to their development. Attention is given to China's place in world politics and its relations with the Soviet Union and other communist states. Mr. Woodruff. 4 credits.

758, 858. Government and Politics of Japan

An analysis of the political, economic, and cultural institutions of contemporary Japan and of the circumstances which helped to shape them. Attention is also given to Japan's place in world politics and its relations with the Soviet Union, China, and the United States. Mr. Woodruff. 4 credits.

763, 863. Political Theory I

An analytical and contextual survey of the origins and character of political philosophy in the West (Aristophanes, Socrates, Plato), of Aristotelian political science, of political thought in the Hellenistic and Roman worlds (Stoics,

Political Science

Epicureans), of Christian political theology (Augustine, Thomas Aquinas), and of the early modern critique of classical and medieval thought (Machiavelli). Mr. Romoser and Mr. Jaffe. 4 credits.

764, 864. Political Theory II

A critical, analytical, and contextual survey of representative modern political theorists. In depth treatment of philosophers whose contributions to political thought have been primary—Hobbes, Locke, Rousseau, Hegel, Marx—will be undertaken as time permits. Mr. Jaffe and Mr. Romoser. 4 credits.

765, 865. Contemporary Political Thought

A study of the theoretical foundations of liberalism, conservatism, and radicalism and of contemporary issues, concerns, and approaches in political thought. Mr. Romoser and Mr. Jaffe. 4 credits.

771, 871. Research in Political Behavior

An introduction to the methodology and techniques of research in political behavior, broadly defined. Emphasis will change from time to time to include various types of empirical research and their optimal use. Such approaches as surveys, experimental designs, and basic data processing techniques will be combined with library and documentary research to produce a significant research paper by each student. 4 credits.

775, 875. International Law

The theory and practice of international law and its relation to the international law and its relation to the international community of nation-states and international organizations. Also, the function of law in international relations as analyzed from the decisions of national and international tribunals and as manifested in constitutions, charters, and other international documents. Permission of instructor. Mr. Larson and Mr. Woodruff. 4 credits.

776, 876. International Organization

The theory of collective security and cooperation and the practice of international organizations as a response to meeting the needs of the international community. Emphasis will be placed upon the League-United Nations system and specialized regional organizations. Mr. Larson and Mr. Romoser. Prerequisite: Political Science 765 or permission of instructor. 4 credits.

779, 879. Public Policy and Regionalism

The regional decision-making process in the United States with shifting public policy emphases. Mr. O'Connell. 4 credits.

795, 796; 895, 896. Selected Topics in Political Science

This course number will be used for special courses that are not regularly offered. Members of the staff. 1-6 credits.

797, 798; 897, 898. Seminars in Political Science

Each seminar is devoted to intensive treatment of a selected topic in political science. Several seminars are offered each semester. Topics are announced in advance, and a listing is available in the departmental office. Primarily for graduate students in the social sciences. Permission of instructor. Members of the departmental Graduate Faculty. 4 credits.

899. Directed Research and Study

4 credits.

Psychology (67)

Chairman: *Raymond L. Erickson*

PROFESSORS: Raymond L. Erickson, George M. Haslerud, Frederick M. Jervis, Robert I. Watson

ASSOCIATE PROFESSORS: Peter S. Fernald, Earl C. Hagstrom, Ronald E. Shor

ASSISTANT PROFESSORS: Robert G. Congdon, G. Alfred Forsyth, Leslie A. Fox, Gordon A. Haaland, Burton I. Klinger, Edward F. Rutledge

Doctor of Philosophy

The Department of Psychology offers a four-year program of study leading to the Doctor of Philosophy degree. The basic goal of the program is the development of behavioral scientists who can carry out sound research in an area of specialization and make meaningful contributions to the field of psychology. The rationale of the program requires that the development of specialized research competence take place within a larger context provided by theoretical and systematic psychology. In addition, a concern with other specific needs of the research psychologist who intends to become a college or university teacher is woven into the program. In his third year, the student has the opportunity to teach a small section of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its goals a deepening of the student's appreciation of the objectives and problems of teaching in the liberal arts.

The student may specialize in one of the three main areas: Experimental, social, or history and theory. Within experimental, substantive areas include perception, cognition, learning, and physiological psychology. The student's guidance committee will counsel with him to help plan an effective graduate program, which will typically require four years. Core courses taken by all students include methodology and statistics, history, theory, and systems in psychology, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in the graduate offerings listed in Group II below, and by independent study and research conducted under the supervision of a staff member. Psychology 895, 896, Reading and Research in Psychology, is specifically designed to serve this purpose.

Prior to his doctoral dissertation, the student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. A Master's degree may be awarded as part of the student's program. Detailed information concerning language requirements and the qualifying examination for advancement to candidacy for the Ph.D. degree can be obtained from the department.

A student admitted to graduate study must meet the requirements for admission to the Graduate School. In applying for admission to the department's program, he must submit Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and his score on the advanced test in psychology.

To be accepted into the program, the applicant must desire to pursue the doctoral degree and be deemed qualified to do so on the basis of initial selection procedures. He need not necessarily have been an undergraduate major in psychology. However, before beginning his graduate career proper, he must have com-

Psychology

pleted a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics, experimental psychology, learning theory, and systematic psychology.

Preference in admission will be given to those who have recently received their bachelor's degree. Only under unusual circumstances will admission be granted to applicants who already hold a master's degree.

Graduate Curriculum in Psychology

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of his guidance committee, his program of research and study leading to the doctoral degree. The range and sequence of seminars will vary to some extent with each student, though there will be common features to all programs.

The 700 series courses are not normally taken for graduate credit, though a student may be advised to enroll in one of these courses as a way of improving his background in the field. Graduate credit for a 700 series course is permitted only with the previous approval of the student's adviser.

701, (701). Contemporary Topics in Psychology

A non-credit seminar focusing on topics of particular interest to students in psychology. Jointly organized by students and faculty to respond to requests of students. Prerequisite: Psychology 401. No credit.

751, 752. The Development and Behavior of Man in the Social System

A systematic examination of normal and abnormal behavior in the context of the social system. Problems of development, personality, and abnormal behavior are considered in the context of social psychological variables. Significant topics are socialization, personality theory, normal and abnormal behavior patterns, and social-influence processes. Prerequisite: Psychology 601. (Psychology 751 is prerequisite to 752.) 3 credits.

758. Psychology of Learning and Motivation

The roles of learning and motivation are studied in relation to contemporary theories of behavior and integrated with other areas of psychology. Emphases are on theory, research methods, and applications. The major concepts and most recent research findings in the areas of learning and motivation are discussed. Prerequisite: Psychology 601. 3 credits.

778. Brain and Behavior

The study of relationships between the nervous system and behavior. The course examines the physiological, neural, and biochemical mechanisms underlying instinct, memory, learning, emotion, and consciousness in man, as well as the evolution of these functions in lower animals. Prerequisite: Psychology 601. 3 credits.

789, (789). Special Topics

Taught by a different staff member each year. The instructor presents advanced material in an area in which he has developed specialized knowledge through research and study. Students may repeat the course, but may not duplicate areas of specialization. Prerequisite: 16 major credits in psychology or permission of instructor. 3 credits.

795. (795). Independent Study

This course provides the opportunity for a psychology major to pursue independent study with a member of the faculty. Arrangements are to be made with a specific faculty member, and enrollment is by permission only. 1-4 credits.

798. The History of Psychology: An Integration

This course provides an opportunity for the major to reassess, extend, and integrate his knowledge of psychology within a historical perspective. Attention is given to antecedents in philosophy and the physical sciences and their relationship to the subsequent development of schools and systems of psychology. In addition, the course examines contemporary thought and research in the field. Normally taken during the senior year. Prerequisite: 20 major credits in psychology or permission of the instructor. 3 credits.

Graduate Seminars in Psychology

Group I (To be taken by all first year students)

801-802. Graduate Proseminar

Students and graduate faculty in psychology meet every two weeks for a mutual exchange on current issues in psychology. No credit.

803-804. History, Theory, and Systems in Psychology

The nature of the science; directed toward increasing the student's awareness of both the strengths and limitations of the approach that characterizes psychology as a behavioral science. Attention is given to the philosophical bases upon which psychological research rests, the nature of psychological inquiry, the history of the study of behavior, and the evolution of theory-building in psychology. Mr. Watson. 3 credits.

809-810. Research Methodology and Statistics I, II

A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction, the theory underlying statistical inference, parametric and non-parametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Mr. Forsyth. Prerequisite: Psychology 567, 568 or their equivalent. 3 credits.

811. Research Methodology and Statistics III

A continuation of Psychology 809-810 covering computer techniques in statistical analysis, factor analysis, and other commonly used multivariate analytical techniques. Mr. Fox. 3 credits.

Group II

815. Developmental Psychology

The genesis and development of behavioral and psychological processes as they contribute to an understanding of: (1) general behavior theory, and (2) the individual at various stages of development. The antecedents, the contemporary determinants, and the process of behavior change are investigated through the

Psychology

examination of selected developmental theories. The current problems and methods of research in psychological development are considered. 3 credits.

820. Measurement and Assessment

A seminar devoted to the nature of measurement in psychology. Emphasis is given both to the techniques for evaluating various assessment procedures and to the theory of data. Current issues in the problems of measurement will be discussed and the course will culminate in a project relating the area of measurement to specific content areas of interest to the student. Mr. Fox. 3 credits.

835. Advanced Psychopathology

The current literature is utilized to gain perspective on the etiology and dynamics of the major forms of pathological behavior. Various theoretical orientations are examined with regard to their implications for the psychotherapeutic process. Mr. Klinger. Prerequisite: Psychology 754 or its equivalent, or permission of instructor. 3 credits.

836. Cognitive Processes

The more complex processes that characterize man. Concept formation, problem solving, creative thinking, and the relationship between cognition and effective behavior are among the topics examined in depth. Mr. Shor. 3 credits.

838. Theories of Behavioral Change

An examination of man's behavior in the process of problem-defining and problem-solving. Recognizing that solutions to problems are based on the definitions of problems, the course examines the process by which problems are defined. The essential nature of functional fixedness or set in problem-solving is examined in relation to insight and creativity. The defining and solving of problems is related to changes in the individual, the organization, and the nation. The course recognizes that man's experiences and his actions are the result of how he defines and attempts to solve problems. Mr. Jervis. 3 credits.

841. Personality Theory

The evolutionary development of the major personality theories, with particular reference to the theoretical, clinical, and experimental contributions to current theories. Mr. Fernald. 3 credits.

843. Psycholinguistics

Issues relevant to the development, structure, and functions of language. Topics include the problem of meaning, acquisition of grammar by the child, personality and voice, and the interrelationship of language and culture. 3 credits.

851. Advanced Social Psychology

A seminar devoted to theoretical and experimental support for major topics of current concern. These may include attitude change, power, interpersonal perception and attraction, roles, interaction, and analysis of structure and function in complex social systems. Mr. Haaland. Prerequisite: Psychology 780 or its equivalent. 3 credits.

862. Psychology of Perception

Experiments and theory concerning the organism's discrimination and interpretation of its apparent environment. An examination is made of perceptual

models in learning and other areas of psychology. The course culminates in independent perceptual experiments carried out individually by each student. Mr. Haslerud. 3 credits.

865. Advanced Physiological Psychology

A seminar devoted to an intensive examination of specific topics relating behavior to its physiological correlates. Among the topics considered are receptor functions, cortical mechanisms, memory, neural correlates of drive states, emotional behavior, and intracranial stimulation. Mr. Hagstrom. Prerequisite: Psychology 778 or its equivalent. 3 credits.

868. Evaluation of the Therapeutic Process

The process of psychotherapy is examined in relation to relevant research findings. The role of the psychotherapist's working-theory is made explicit by showing its effect upon inferences made, goals set, and methods employed in changing the client. The student learns methods of evaluating various theoretical positions, including the identification of basic assumptions that underlie them. He is encouraged to identify the basic assumptions upon which he bases his own theoretical position. Mr. Jervis. 3 credits.

870. Advanced Psychology of Learning

Problems in conditioning and other forms of learning. Emphasis is given to the evaluation of current experimental and theoretical literature. Mr. Rutledge. Prerequisite: Psychology 758 or its equivalent. 3 credits.

Group III

891-892. Seminar and Practicum in the Teaching of Psychology

Typical problems encountered in teaching psychology on the college level, including an examination of the implications of the liberal arts philosophy for teaching. Under close supervision of the staff, the student will be given an opportunity to teach an undergraduate section of introductory psychology. The seminar and practicum operate in close coordination throughout the year. Required of all doctoral students, typically during the third year. Mr. Erickson. 5 credits.

895, 896. Reading and Research in Psychology

As part of his development as an independent scholar, the student is encouraged to plan: (1) broad reading in an area, (2) intensive investigation of a special problem, or (3) experimental testing of a particular question. The project may involve library research, empirical research, or both. Registration must be acceptable to the student's guidance committee and to the staff member who has agreed to serve as his adviser on the project. May be repeated. Staff. 3-6 credits per semester.

897, 898. Problems and Issues in Psychology

A seminar to be offered by one or more members of the staff concerning problems and issues of special importance in the current development of the field. On occasion the seminar will feature a problem which has been the subject of specialized research and study by a member of the staff. The personnel and topical focus will vary from year to year, and the course may be repeated by the student. Staff. 3 credits.

Resource Economics

899. Master's Thesis

Each student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. 6 credits.

999. Doctoral Research

Group IV (Graduate courses offered primarily for students enrolled in other graduate programs)

822. Case Studies in Counseling

Case studies are used to illuminate the differences among a variety of personality theories and counseling techniques. The seminar is designed to help develop an appreciation of the complexities of human behavior, to gain increased respect for the integrity of individuals and their difficulties in revealing themselves to a counselor, and to understand better the difficulties encountered in applying theoretical knowledge to the counseling situation. Mr. Carroll. 3 credits. (Offered only in the summer.)

823. Individual Testing

Training in the administration, scoring, and interpretation of individual tests of intelligence. Such instruments as the Wechsler Adult Intelligence Scale, the Stanford-Binet, and the Wechsler Intelligence Scale for Children will be critically analyzed. Each student will be required to purchase one set of tests materials. Miss Riggs. Prerequisite: permission of instructor. (Adequacy of the student's background in statistics, measurement, and personality theory will be evaluated by the instructor.) 1 lecture; 1 laboratory; 4 credits.

Resource Economics (21)

Chairman: *James R. Bowring*

PROFESSORS: James R. Bowring, William H. Drew, William F. Henry

ADJUNCT PROFESSORS: George E. Frick, Nelson L. LeRay

ASSOCIATE PROFESSORS: Richard A. Andrews, Owen B. Durgin, Edmund F. Jansen

ASSISTANT PROFESSORS: Chauncy T. K. Chinz, Sherrill B. Nott

Admission to graduate study in Resource Economics may be granted those who have satisfied the requirements for admission to the Graduate School and who present evidence of satisfactory undergraduate training. Normally this will include nine or more credits in economics, including resource or agricultural economics, as evidence of aptitude for advanced training in the field. In addition, the Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and the score on the advanced test in Economics must be presented. Candidates for the Master of Science degree will be required to pass a final examination. An acceptable thesis is normally a requirement for the degree, but approved course work may be substituted for the thesis.

705. Structure, Economic Problems, and Planning of Communities in the Non-Urban Environment

The community is taken as an economic unit and analyzed using appropriate methodologies with emphasis on economic growth. Economic forces, as they

relate to employment, income, transportation, housing, etc., are analyzed. Community income, expenditures and public services are taken in the context of growth and planning. Mr. LeRay. Prerequisite: 1 course in Social Science. 4 credits.

706. Economics of Resource Development

The classical and modern theories of economic development. Economic problems of land and resources in relation to market location, urban-rural conflicting demands, and conservation and water supply. Population mobility, capital needs, and the roles of public and private leadership will complete the framework for discussion of the major resource development problems of New England. Mr. Bowring. Prerequisite: Economics 401. 4 credits.

708. Research Methods in Social Sciences

The scientific method of research. Analysis of research problems in social sciences. The design of research and the application of research techniques to identifying and solving problems. May be used in place of Sociology 702. Mr. Drew. Prerequisite: 3 hours of statistics. 4 credits.

715. Linear Programming Methods

Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications, non-linear programming, discrete programming, and solving input-output and game theory problems. Applications to firm and aggregate economic analysis. Mr. Andrews. Prerequisite: Mathematics 407 or permission of instructor. 4 credits.

758. Introduction to the Location of Economic Activity

Economic theories explaining the behavior of individual firms and consumers in selecting sites for carrying on economic activities. The relationship of these theories to patterns of industrial location, systems of cities, and land-use competition in general. Problems of locational change and adjustment and the effects of public policy on spatial economic activities. Mr. Ching. Prerequisite: Resource Economics 715 or its equivalent, Mathematics 425 or its equivalent, or permission of the instructor. 4 credits.

804. Economics of Production and Resource Use

Principles of choice, resource use, and production under perfect and imperfect knowledge. The economic theory of resource allocation and the use of this theory in problem solving. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, uncertainty, and interfirm relations. Mr. Andrews. 3 credits.

807. Statistical Analysis

Statistical measurement and research tools for use in the physical and social sciences. Regression, analysis of variance, factorial analysis, covariance, time series, sampling, and experimental design. Mr. Ching. 4 credits.

809. Agricultural Economics

Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision-making in food production, marketing, and consumption, and on the competitive structure of the food industry. Mr. Henry. 3 credits.

Sociology

895-896. Investigations in Resource Economics

Human-resource development, legal problems in resource development, economics of outdoor recreation, community development. Staff. 4 credits.

899. Thesis

To be arranged. 6-10 credits.

Sociology (68)

Chairman: *Stuart Palmer*

PROFESSORS: Richard S. Dewey, Stuart Palmer, Solomon Poll, Murray A. Straus

ASSOCIATE PROFESSORS: Melvin T. Bobick, Peter Dodge, Richard E. Downs, Bud B. Khleif

ASSISTANT PROFESSORS: Thomas R. Burns, Richard L. Ingersoll, Arnold S. Linsky, Amnon Orent, Fred Samuels

The Department of Sociology offers a program of graduate study leading to the degrees of Master of Arts and Doctor of Philosophy. The Master of Arts curriculum is largely designed to give the student the opportunity to acquire professional competence in the core areas of theory and methodology; the Doctor of Philosophy program presents the candidate with three substantive areas for possible specialization: social disorganization, social psychology, and comparative institutional analysis.

The student's proficiency in theory, statistics, and methods, and in the major and minor areas of study is determined by examination. No specific courses are required of all students. Within the context of a curriculum, principally organized in the form of seminars and research under the supervision of assigned faculty members, the student is expected to select from the departmental specializations one major and one minor area for intensive study, which may in specified cases extend to work in contiguous disciplines. In designing the program most appropriate to the individual, his advisers will take into consideration both his past experience and his intellectual goals, and, given the guidelines sketched above, flexibility will be emphasized. The selection of dissertation topic is thus limited only by the areas of expertise available among departmental faculty members.

To be awarded the Master of Arts degree the candidate must fulfill the following requirements:

- (1) Complete satisfactorily 24 hours of graduate level course work.
- (2) Pass a two-hour examination on theory and methodology.
- (3) Demonstrate proficiency, in translating into English, sociological writings in a foreign language.
- (4) Write an acceptable Master's thesis.

To be awarded the Doctor of Philosophy degree the candidate must fulfill the following additional requirements:

- (1) Complete satisfactorily at least one full year of course work after the Master of Arts degree as well as the residence requirement of three year's work after the Bachelor of Arts degree.
- (2) Pass an oral and written examination in his major and minor areas of specialization.

- (3) Demonstrate advanced reading knowledge of a foreign language. With the permission of his adviser and the Graduate Committee, a student may substitute for proficiency in a single language either: a. intermediate reading knowledge of two languages, or b. intermediate reading knowledge of one language and knowledge of a research tool not normally required of graduate students in sociology, such as symbolic logic, historiography, computer programming, econometric techniques, and mathematical statistics.
- (4) Write and defend an acceptable doctoral dissertation.

Partly on the basis of an initial comprehensive examination, the student will be advised during the first year of graduate study by an assigned faculty member in planning his program and thereafter by a guidance committee. Instructors filling these functions will also ordinarily be found with others as members of specially appointed committees for the direction and assessment of the student's thesis and dissertation. Under such supervision the student is expected to go considerably beyond the minimal common requirements of the graduate program to establish a knowledgeability and competency peculiarly his own. In the absence of other obligations, he is expected to enroll during each semester in three graduate courses until he has completed at least 12 such courses, outside of preparation of thesis and dissertation. He will be permitted to take courses outside the department or below the 800 level within the department only with the express permission of his adviser.

To be accepted as a graduate student in sociology, the applicant must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and his score on the advanced test in sociology. Undergraduate majors in the other social sciences, and others who have had a minimum of 18 credits in sociology, are regarded as suitable candidates for admission; but in some cases the comprehensive examination used to assess first-year students may also be required for admission. Ordinarily students will be admitted in the expectation of their completing the entire graduate program. Well-qualified applicants for a terminal Master of Arts degree will, however, be given full consideration.

701. Statistics

Use of elementary statistical techniques in analysis of prepared data. Topics include probability, discrete and continuous probability distribution, distributions of sample statistics, small sample theory, elementary analysis of variance, regression, correlation, and the *Chi* square. 3 credits.

702. Quantitative Methods of Social Research

Analysis of research problems; designing field studies and experiments; demonstration and practice in sampling, schedule construction, and interviewing techniques. Students not majoring in sociology or enrolled in the social service curriculum may be admitted by permission of instructor. Prerequisite: Sociology 701. 3 credits.

703, (703). Criminology

The scientific study and control of crime. The following are considered: indexes, rates and theories of crime and delinquency, police, courts, probation, prison, and parole. 3 credits.

711, 712. Development of Sociological Theory

Social thought from Plato to the present. First semester: the works of selected individuals from Plato to Comte. Second semester: the nineteenth century European social philosophers; the ideas of U. S. social scientists, especially their contributions to present day sociological thought. Students not majoring in sociology may be admitted by permission of instructor. 3 credits.

720. Current Developments in Family Sociology

Study of the theoretical and empirical research on specific aspects of the family. A different topic will be selected each semester to reflect issues of current importance, for example: stratification and the family, intra-family communication, power structure of the family, kinship in modern societies. In addition to critical review of the literature, a class or individual research project will usually be carried out. Prerequisite: 6 credits of sociology, Sociology 520 recommended. 4 credits.

727. Public Policy in Social and Labor Legislation

American social and labor legislation of the recent decades. An opportunity is provided to study the way in which American economic and human values have been implemented and modified by law. Attention will be given to legislation and private industry programs in social security, reemployment, unemployment insurance, health services, training and retraining, and fair employment practice. Lectures, discussion, assigned reading, and individual student projects. Prerequisite: one year's work in economics or sociology. 3 credits. (Also offered as Economics 727.)

735. Complex Organizations

Analysis of the structure and dynamics of complex, formal organizations (business, military, political and governmental, and educational). Emphasis on the construction of theory to account for the findings of empirical studies, both historical and comparative. Special problems treated in the course: power and social control in formal systems; organizational processes, performances, and effectiveness; impact of complex, formal organizations on persons and societies. Prerequisite: permission of instructor. 4 credits.

740. Culture Change

Various types of society are studied leading to the development of a theory of culture change. Descriptive studies of institutional as well as theoretical materials, selected from the writings of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. Prerequisite: Sociology 400 or permission of instructor. 3 credits.

741. Social Change and Societal Development

Comparative, interdisciplinary approach to the study of social change. The course focuses on the interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prerequisite: permission of instructor. 4 credits.

743. Social Movements

The factors related to the origin and development of reforms, and revolutionary, religious, and other social movements. Generalizations concerning the

organizations, structure, tactics, and leadership of social movements and social change. Prerequisite: Sociology 400. 3 credits.

745. Social Stratification

The pattern of distribution of economic, honorific, and political variables within the populations of complex societies; the allocation of personnel to the roles in question, notably through occupational mobility; and the impact of such processes upon behavior, both individual and social. 3 credits.

751. Sub-Saharan African Social Systems

The stress will be on the analysis of segmentary and non-segmentary systems in terms of their variation throughout the continent. The focus will be on "how" these societies solve the problems of daily living in terms of the tribe, clan, and lineage. Prerequisite: Introductory Anthropology or Introductory Sociology. 4 credits.

752. Social Problems in Modern Africa

The focus will be on urban and rural adjustments (acculturation) of tribal systems in Africa (below the Sahara) to the 20th century. This course is a follow-up of Sociology 751 although the latter is not a prerequisite. Prerequisite: Introductory Anthropology or Introductory Sociology. A background in sociological theory and methods is desirable. 4 credits.

755. Ethnography of Southeast Asia

The geographical, racial, cultural, and historical factors in the development of the area, together with detailed examinations of selected peoples and aspects of their culture. Prerequisite: Sociology 411 or permission of instructor. 3 credits.

761. Population Dynamics

Examination of major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development. Emphasis is on the interrelationship of population and society. 3 credits.

770. Culture, Personality, and Society

Emergence of personality from the matrix of genetic, situational, and socio-cultural determinants viewed in cross-cultural perspective; dynamic interplay of the sociocultural and psychological behavioral systems. Prerequisite: permission of instructor. 3 credits.

780. Social Conflict

The nature of social conflict, especially war, will be investigated. The setting and initiation of conflict, its dynamics, and the factors affecting its course and outcome will be analyzed. Prerequisite: permission of instructor. 4 credits.

801. Sociological Methods I. Intermediate Social Statistics

Application of descriptive and inductive statistical methods to the analysis of sociological data, including sampling distributions, statistical decision-making, analysis of variance, correlation and regression, and nonparametric measures. Prerequisite: Sociology 701 or permission of instructor. 4 credits.

Sociology

802. Sociological Methods II. Research Design

Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses will be pursued. Prerequisite: Sociology 701 and 702 or their equivalent or permission of instructor. 4 credits.

803. Sociological Methods III. Special Problems in Methods and Statistics

Attention is focused on one or more special problems in sociological research such as the following: measurement and scaling, field and laboratory experiments in sociology, multivariate analysis, historical methods, community studies, mathematical models in sociological research, and survey design and analysis. Prerequisite: Sociology 801 and 802. 4 credits.

805. Sociology as a Profession

Sociological analysis of teaching and research in sociology, including the social organization of the discipline and social psychological aspects of careers in sociology. Although primarily a seminar on the sociology of science and the sociology of education, the materials covered also provide professional orientation for a career in sociology. 4 credits.

811. Sociological Theory I

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prerequisite: Sociology 711 and 712 or their equivalents. 4 credits.

812. Sociological Theory II

The content, presuppositions, and implications of contemporary sociological theory. The student will engage in theory construction and analysis, and in this endeavor will be encouraged to develop his particular interests in substantive areas. Prerequisite: Sociology 811. 4 credits.

813. Sociological Theory III

A seminar of intensive study of specific figures and movements in sociological theory. Sample topics include: Max Weber; evolution, pragmatism, and reform; and classical social theory. Prerequisite: Sociology 711 and 712 or their equivalents. 4 credits.

821. Deviant Behavior

A seminar in which attention is directed to the relationships among cultural, subcultural, and personality variables and deviant behavior. Special emphasis is placed on the following forms of deviant behavior: invention, crime, alcoholism, and emotional illness. 4 credits.

830. The Small Group

The small group as a unit for sociological study, for the testing and the developing of hypotheses. Both the behavioral and the attitudinal levels shall be considered with respect to group intraaction and group-to-group interaction. The effects of different independent variables upon group structure shall be of particular interest. 4 credits.

852. Socialization and Abnormal Behavior

A seminar concerned with socialization and the effects of socialization on abnormal behavior. A survey of those orientations that relate socialization to abnormal behavior with the aim of synthesizing the major concepts into current sociological and social-psychological frames of reference. In addition, emphasis will be placed on the methodological problems of research concerned with socialization. Prerequisite: at least one course in social psychology or permission of instructor. 4 credits.

854. Sociology of Religion

Critical analysis of the reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change, and the problem of church and state. 4 credits.

861. Demography

Survey and analysis of current problem areas in demography, including: fertility, mortality, migration, population growth, population theory, formal demography, and the use of demographic sources and techniques in sociological investigation. Prerequisite: introductory undergraduate course in demography or permission of instructor. 4 credits.

870. Comparative Institutional Analysis

Theoretical and methodological aspects of cross-national, comparative research in sociology, including: history of comparative research, examination of differences in objectives and methods employed, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prerequisite: 701, 702. 4 credits.

871. Social Institutions of Latin America and the Caribbean

Selective analysis of distinctive institutions and social systems, with particular attention to social aspect of the process of modernization. Prerequisite: permission of instructor. 4 credits.

895, 896. Reading and Research in Sociology and Anthropology

A student prepared by training and experience to do independent work under the guidance of an instructor may register for one or more of the following sections: (1) Communications, (2) Criminology, (3) Cultural Anthropology, (4) Cultural Change, (5) Culture and Personality, (6) Deviant Behavior, (7) Ethnology, (8) Population, (9) Rural-Urban, (10) Social Control, (11) Social Differentiation, (12) Social Movements, (13) Social Psychology, (14) Social Research, and (15) Social Theory. Prerequisite: 12 hours of sociology and permission of instructor. Hours and credit to be arranged.

897, 898. Special Topics Seminar

Under the direction of members of the department on the basis of rotation and interest, seminars are offered in those fields listed under Sociology 895, 896. Prerequisite: permission of instructor. 4 credits.

899. Master's Thesis

Usually 6 credits, but up to 10 credits when the problem warrants.

Soil and Water Science

999. Doctoral Research

Soil and Water Science (23)

Chairman: *Gordon L. Byers*

PROFESSOR: Gordon L. Byers

ASSOCIATE PROFESSORS: Francis R. Hall, Nobel K. Peterson

ASSISTANT PROFESSOR: Glendon W. Gee

Students admitted to graduate standing in Soil and Water Science are required to have had adequate preparation in chemistry, physics, mathematics, and the biological or earth sciences. The major fields for graduate study are soil chemistry, soil physics, and hydrology; however, combined or more flexible programs may be arranged. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and thesis.

Students interested in the Soil and Water Chemistry Option in the Chemistry Department's Ph.D. program should refer to pages 47 and 99.

701. Physical Properties of Soil-Water-Plant Systems

Physical properties of soils in relation to their composition, formation, classification, and use as a vital resource. Structure, texture, water retention, and heat transfer in relation to plant growth. Methods of soil physical analysis. Mr. Gee. Prerequisites: 1 year of physics and 1 year of calculus. 3 lectures; 1 laboratory; 4 credits.

702. Chemical Properties of Soil-Water-Plant Systems

Chemical properties of soils in relation to their composition, formation, classification, and use as a vital resource. Exchange and fixation of elements in soils and their relation to plant growth. Methods of soils chemical analysis. Prerequisites: 1 year of chemistry and 1 year of calculus. 3 lectures; 1 laboratory; 4 credits.

703. Soil and Water Engineering

The treatment of engineering principles relating to the control of water. Major topics include precipitation and stream-flow measurement, estimating run off from a watershed, and the design of structures to control this runoff. Subsurface drainage and irrigation systems are studied in detail. Laboratory sessions are designed to acquaint the student with instrumentation and problem analysis. Mr. Byers. Prerequisite: permission of instructor. 3 lectures; 1 laboratory; 4 credits.

704. Soil Classification

Soils are studied in relation to the genesis, morphology, and classification including the current U.S.D.A. soil classification system. The five major factors affecting soil development are reviewed in detail as are the soils found in the United States with special attention on New Hampshire. Emphasis is placed on the importance of chemical and physical characteristics. Mr. Peterson. Prerequisites: Soil and Water Science 501 and a basic geology course or permission of the instructor. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1969-70.)

705. Principles of Hydrology

A study of the physical and chemical processes involved in the movement of water through the rainfall-runoff segment of the hydrologic cycle. Major topics include infiltration and percolation, overland and channel flow, channel processes, and the nature of the stream-discharge record or hydrograph. Laboratory sessions involve the use of a demonstration channel, electrical and fluid models, and selected problems to demonstrate important principles. Mr. Hall. Prerequisites: 1 year of geology and 1 year of calculus. 3 lectures; 1 laboratory; 4 credits.

709. Soil Interpretation and Community Planning

A review is presented of placement of soils in the classification system used in the United States in relation to the interpretation of soils data for multiple uses such as housing, recreation, sewage effluent disposal, conservation, transportation, surface runoff, and other soil-use problems common to most communities. Students study soils maps prepared on a town or city basis especially for community planning activities. Mr. Peterson. 2 lectures; 2 credits.

710. Ground-Water Hydrology

Introduction to the principles governing the occurrence, location, and development of ground water. Major topics include well hydraulics, geophysical exploration, and chemical quality of water. Brief treatment given of water law and economics. Laboratory sessions are designed to illustrate principles by use of fluid and electrical models, geophysical instruments, and selected problems. Mr. Hall. Prerequisite: Soil and Water Science 703 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

801. Advanced Soil Physics

The physics of unsaturated water flow. Theory of infiltration and drainage. Application of unsaturated water-flow theory to soil-plant-atmosphere systems. Mr. Gee. Prerequisite: permission of instructor. 3 lectures; 3 credits.

802. Advanced Soil Chemistry

Physical chemistry of soils and soil colloidal phenomena. Anion and cation exchange mechanism in soils. Theories of swelling. Crystallographic properties of the clay colloids and their relation to cation and anion exchange. The nature of soil acidity. Oxidation-reduction phenomena in soils. Permission of instructor. 3 credits.

803. Advanced Ground-Water Hydrology

Application of analytic techniques to ground-water systems. The emphasis is on development of mathematical, statistical, and graphical methods that can be applied to selected problems. Major topics include radial flow to wells, lateral flow to streams and drains, flow-set analysis, and simulation methods including fluid models, electric analog models, and digital computers. Brief treatment given of multiple-well problems and two-phase, fluid-flow systems. Mr. Hall. Prerequisite: Soil and Water Science 710 or permission of the instructor. 2 lectures; 1 laboratory; 3 credits.

804. Hydrochemistry

The chemical principles for dilute aqueous solutions at relatively low temperatures and pressures are applied to the study of fresh waters at or near the

Spanish and Classics

earth's surface. Major topics include equilibrium concepts, buffering mechanisms, oxidation-reduction reactions, and ion exchange. Particular emphasis is given to selected systems involving water, carbon dioxide, calcium carbonate, and silicate minerals. Laboratory exercises utilize simple experiments to give experience with methods of measurement and interpretation of results. Mr. Hall. Prerequisite: 2 years of chemistry or equivalent or permission of instructor. 2 lectures: 1 laboratory; 3 credits.

895-896. Investigations in Soil and Water Science

Offered in: (1) Soil-Plant Relationships, Mr. Peterson. (2) Physics of Soils, Mr. Gee. (3) Hydrology, Mr. Byers and Mr. Hall. (4) Chemistry of Water, Mr. Hall. (5) Chemistry of Soils, Mr. Gee. (6) Soil Classification, Mr. Peterson. Elective only after consultation with the instructor in charge. 1-4 credits.

899, (899). Master's Thesis

A thesis study of some phase of soil and water science is required of all candidates for the M.S. degree. 6-10 credits.

Spanish and Classics

Chairman: *Charles H. Leighton*

PROFESSOR: Alberto R. Casas

ASSOCIATE PROFESSOR: Charles H. Leighton

The Department of Spanish and Classics offers courses leading to two degrees in Spanish, the Master of Arts and the Master of Science for Teachers. To be admitted to graduate study for the Master of Arts degree in Spanish, a student must have met requirements substantially equal to those set up for an undergraduate major in that language at the University. In addition, all candidates for admission to the graduate program in Spanish must take the general Graduate Record Examination and the advanced test in Spanish. To obtain the degree, the student must fulfill the course requirement and submit an acceptable thesis.

To satisfy the course requirement, he must complete at least 24 credits of graduate work selected from the courses listed below (6 credits are granted for the thesis thus completing the total of 30 required by the Graduate School).

To take a course numbered 850-898, a student must register for the corresponding undergraduate course numbered 750-798, pass it with a grade of B or better, do supplementary work assigned by the instructor, and prepare a paper of graduate quality on a topic assigned by the instructor. No student may register for a graduate course if he has already taken the corresponding undergraduate course here or its equivalent elsewhere.

Before undertaking work on the thesis, the student must pass a comprehensive written examination. The examination will be given four times a year: in January, May, August, and September. The candidate will be permitted to take the examination only twice. If he fails in his first attempt, he must wait at least three months before taking it again. The thesis must embody the results of independent investigation and be written in a form acceptable to the department. It must be submitted to the thesis director before April 20 of the academic year in which the degree is to be granted.

To be admitted to graduate study for the Master of Science for Teachers degree in Spanish, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in the language. To obtain the degree, he must complete 30 semester hours of work at the graduate level. Since it is intended for teachers already in service, courses leading to this degree will normally be chosen from Summer Session offerings. Secondary school teachers interested in this degree should consult the Department Chairman.

Spanish (62)

851. Spanish Literature up to 1600

Readings and discussion of the great human creations of early Spanish Literature, such as *El Poema de Mio Cid*, *El Libro de Buen Amor* and *La Celestina*, and their social and historical background. The course will cover Spanish literature before Cervantes. Conducted in Spanish. Prerequisite: Spanish 505 or equivalent. 3 credits.

852. Drama and Poetry of the Siglo de Oro

The social background of the baroque period. Readings of representative plays of Lope de Vega, Tirso de Molina, Caleron, and the poetry of Lope, Gongora, and Quevedo. Development of the prose of the period. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

854. Cervantes

The development of Cervantes' literary art. Reading and discussion of selections from all the major works of Cervantes. Comprehensive study of the *Quijote*, its originality and significance; its antecedents; its religious, philosophical and sociological aspects; and its artistic structure. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

855. Literature of the Nineteenth Century

Preliminary survey of the eighteenth century and readings and discussion in the main literary movements of the nineteenth century. Selections from Quintana, E-pronceda, Zorrilla, Larra, Duque de Rivas, Bécquer, Pérez Galdos, Valera, Pereda, Clarin, and Echegaray. Social and historical background of Spain in relation to nineteenth century thought in Europe. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

856. Contemporary Spanish Literature

Starting with the generation of 1898, readings and discussion of the works of such writers as Unamuno, Azorin, Baroja, Machado, J. R. Jiménez, Ortega Y Gasset, Garca Lorca, Pérez de Ayala, Benavente, and Casona, plus a survey of Spanish literature and thought since 1939. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

865. 866. Spanish American Literature

The main themes of Spanish American literature studied in the works of its most representative authors and against the historical, social, and geographical background of the New World. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

Technology

891. Spanish-Education: Problems in the Teaching of Spanish in the High School

The special objectives, methods, and devices of modern-language teaching in high school. For prospective or actual teachers of Spanish. Prerequisite: intermediate Spanish; and grade of C or better in Education 648 or one year's teaching experience. 3 credits.

895, 896. Special Studies in Spanish Language and Literature

Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Staff. Conducted in Spanish. Prerequisite: permission of Department Chairman. Variable credit.

899. Master's Thesis

6 credits.

Technology (79)

Dean: *Richard S. Davis*

601. Statistical Methods in Engineering and Physical Science

Methods of organizing data and statistical techniques for data analysis, as applied to problems in engineering and physical science. Elementary probability theory and probability distributions. Correlation and regression analysis. Design of experiments; factorials, fractional factorials, designs for process optimization. Introduction to quality control; construction and analysis control charts for variables and attributes; statistical aspects of tolerance. 4 credits.

780. Engineering Analysis

The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. Prerequisite: permission of instructor. 4 credits.

Zoology (70)

Chairman: *Paul A. Wright*

PROFESSORS: Wilbur L. Bullock, Louis J. Milne, Emery F. Swan, Paul A. Wright

ASSOCIATE PROFESSORS: Arthur C. Borrer, Frank K. Hoornbeek, Marcel E. Lavoie, Philip J. Sawyer, Paul E. Schaefer

ASSISTANT PROFESSORS: Robert A. Croker, John E. Foret, Edward N. Francq, John J. Sasner, Edward K. Tillinghast

To be admitted to graduate study in Zoology, a student must have completed an undergraduate major in biology or zoology. In addition to a basic array of zoology courses, botany, chemistry, mathematics, physics, and, for those students intending to apply for the Doctor of Philosophy degree, two foreign languages (usually French and German) are also necessary. Students lacking one of these requirements may occasionally be admitted but will be required to complete certain courses which do not give graduate credit.

Candidates for the Master's degree in Zoology will be required to pass a written examination covering their general knowledge of the biological sciences. A Master's student may elect to submit a thesis in partial fulfillment of degree requirements.

Students who apply for admission to the Doctor of Philosophy program must demonstrate to the satisfaction of the guidance committee proficiency in reading zoological literature in two foreign languages, usually French and German, and demonstrate to the doctoral committee a broad basic knowledge of the field of Zoology and cognate sciences, by means of oral and written qualifying examinations. Before being finally accepted as a doctoral student, and preferably during his Master's program, each student must demonstrate indication of his research capabilities. Students who begin their graduate work at New Hampshire will ordinarily meet this requirement by completing a special problem (Zoology 895, 896), acceptable to the proposed major professor, or a master's thesis (Zoology 899).

701, (701). Principles of Ecology

The interrelationships of plants and animals with both their living and non-living environments. Energy relationships, limiting factors, community organization, succession, and biogeography. Staff. Prerequisite: Zoology 412 or equivalent. 4 credits.

703. Genetics

A course intended for students desiring a more detailed training in fundamental genetics. Required for genetics students; elective for others. Mr. Hoornbeek. Prerequisite: Zoology 604 or equivalent. 4 credits.

704. Comparative Endocrinology

The various endocrine organs, vertebrate and invertebrate, with particular emphasis on endocrines which relate to physiology of reproduction. Mr. Wright or Mr. Tillinghast. Prerequisite: vertebrate anatomy and physiology, organic chemistry. 4 credits.

711. Natural History of Cold-Blooded Vertebrates

The various classes of poikilothermic vertebrates, their habits, habitats, and life histories, with special reference to those occurring in eastern North America. Mr. Sawyer. Prerequisite: general zoology and zoology 508. 4 credits.

(712). Mammalogy

The origin and diversification of mammals, their ecology and economic importance. Laboratories will emphasize techniques of the mammalogist and identification of local forms. Mr. Francq. Prerequisite: general zoology and Zoology 508. 4 credits.

(713). Animal Behavior

Individual and group behavior patterns of animals with the role of anatomy, physiology, and prior experience emphasized. Techniques and the practical application of the study of animal behavior. Mr. Francq. Prerequisite: one year of zoology. 4 credits.

(715). Natural History of Marine Invertebrates

A field and laboratory course aimed at acquainting the student with the inshore marine invertebrate metazoan animals of northern New England. Emphasis will be on identification, classification, habitat preferences, and behavior

Zoology

of these animals. Field work (collections and observation) will constitute a major part of the course and the student must be prepared to assume some travel expense. Mr. Croker. Prerequisite: general zoology. 4 credits. (Also offered in Summer Session.)

721. Parasitology

An introductory course on some of the more important parasites causing disease of man and animals. Living materials will be used as far as possible. Mr. Bullock. Prerequisite: one year of zoology. 4 credits.

725. General Physiology

The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction. Mr. Sasner. Prerequisite: one year of zoology and organic chemistry. 4 credits.

729. Vertebrate Morphogenesis

The fundamental principles of vertebrate growth and development including embryology, metamorphosis, regeneration, and oncology. Mr. Foret. Prerequisite: general zoology. 4 credits.

730. Elements of Histology

The microscopic anatomy of principal tissues and organs of vertebrates. Mr. Bullock. Prerequisite: Zoology 508 or equivalent or permission of instructor. 4 credits.

772. Fishery Biology

Designed to introduce the student to some of the information and techniques used by the freshwater fishery biologist. Emphasis on freshwater fisheries, but many of the techniques and some of the reading pertain as well to salt water fisheries. Mr. Sawyer. Prerequisite: Zoology 711 or equivalent. and permission of instructor. 4 credits.

795, 796. Special Problems in Zoology

Election of one or more sections of this course provides opportunity for advanced study. Work may involve reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of staff concerned. 2 or 4 credits. (Limit of 12 credits from the sections of this course.) Section numbers and subject-matter fields are: (1) Bibliographic Methods, (2) Ecology, (3) Endocrinology, (4) Evolution, (5) Developmental Biology, (6) Genetics, (7) Histology, (8) History of Zoology, (9) Invertebrate Zoology, (10) Physiology, (11) Vertebrate Zoology, (12) Zoogeography, (13) Zoological Techniques, (14) Parasitology, (15) Histochemistry, (16) Protozoology, (17) Systematics, (18) Animal Behavior.

801. Freshwater Ecology

An introduction to some of the chemical, physical, and biological facets of the special relationships between freshwater organisms and their environment. Laboratories will include limnological techniques and others necessary for analyzing the variations in freshwater habitat. Mr. Sawyer. Prerequisite: Zoology 701; courses in physics, chemistry, invertebrate and vertebrate zoology, geology,

algology, and aquatic entomology are desirable. 4 credits. (Alternate years; offered in 1969-70.)

(803). Marine Ecology

The marine environment and its biota, with emphasis on intertidal and estuarine habitats. Laboratory and field work will stress inquiry and the application of ecological, physiological, behavioral, biometrical, systematic, and chemical techniques to local problems. Field trips may be scheduled for early morning, late afternoon, or weekends. Travel will be at student's expense, and should not exceed \$30 for the course. Mr. Croker. Prerequisite: Zoology 701 or equivalent. 4 credits.

(820), (821). Invertebrate Zoology

The morphology, phylogeny, and natural history of the major invertebrate groups. Mr. Swan and Mr. Croker. Prerequisite: general zoology; Zoology 715 desirable. 4 credits.

(822). Protozoology

The general biology of Protozoa with particular emphasis on morphology, natural history, and economic importance. Mr. Borrer. Prerequisite: Zoology 721 or 820 or permission of instructor. 4 credits. (Alternate years; offered in 1969-70.)

823. The Host-Parasite Relationship

Examination of the interactions of host and parasite, using examples from fish, wildlife, and human parasitology. Particular attention will be given to ways in which host ecology influences parasite populations, and the interplay of host and parasite in parasite pathology and immunology. Mr. Bullock. Prerequisite: previous training in parasitology, histology, and ecology desirable. 4 credits.

(824). Advanced Parasitology

The basic principles of parasitism as exhibited by various groups of Protozoa and helminths. Emphasis on life cycles, ecology, and host-parasite relationships. Mr. Bullock. Prerequisite: Zoology 721. 2 lectures; 2 laboratories; 4 credits. (Alternate years; not offered in 1969-70.)

826. Comparative Physiology

The means whereby animals, chiefly invertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Sasner. Prerequisite: Zoology 725. 4 credits.

828. Experimental Embryology

An examination of cellular differentiation during development. Laboratories will illustrate important techniques in experimental morphogenesis. Mr. Foret. Prerequisite: Zoology 729 or equivalent. 4 credits.

830. Invertebrate Embryology

The developmental patterns as exhibited by the major invertebrate groups. This will be essentially a descriptive study based upon lectures, library, and laboratory work with living material. Mr. Foret. Prerequisite: Zoology 820, 821. 4 credits. (Offered in Summer, 1969.)

Zoology

836. Topics in Genetics

Selected topics in fundamental and physiological genetics. Emphasis will be on recombination, phenogenetics, and lethal genes. Mr. Hoornbeek. Prerequisite: Zoology 703 or equivalent. 3 credits. (Alternate years; not offered in 1969-70.)

895, 896. Advanced Studies in Zoology

The sections of this course provide opportunity for advanced work either on an individual or group seminar basis. They may involve reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of Department Chairman and staff concerned. 2 or 4 credits. Sections of this course are the same as those listed under Zoology 795, 796.

897, 898. Zoology Seminar

Preparation, presentation, and discussion of reports of recent zoological literature. Subject matter fields are the same as those listed under Zoology 795, 796. Not all areas will be available every semester. Required of graduate students in zoology. Staff. No credit.

899. Master's Thesis

Open to students who wish to do independent, original research. Prerequisite: permission of Department Chairman and prospective supervisor. 6 credits.

999. Doctoral Research

Open to students who have declared their intention of proceeding to candidacy for the Doctor of Philosophy degree.

Faculty of the Graduate School

Fred E. Allen, *Professor of Animal Science*

D.V.M., Ohio State University

Robert W. Alperi, *Assistant Professor of Mechanical Engineering*

M.S., Rensselaer Polytechnic Institute; PH.D., University of Connecticut

Alexander R. Amell, *Professor of Chemistry*

PH.D., University of Wisconsin

Franz E. Anderson, *Assistant Professor of Geology*

M.S., Northwestern University; PH.D., University of Washington

Kenneth K. Anderson, *Associate Professor of Chemistry*

PH.D., University of Minnesota

Michael D. Andrew, *Assistant Professor of Education*

A.M.T., Harvard University

Richard A. Andrews, *Associate Professor of Resource Economics*

M.S., Pennsylvania State University; PH.D., University of Minnesota

William H. Annis, *Associate Professor of Agricultural Education*

M.AG.ED., University of New Hampshire; ED.D., Cornell University

Roger Arnoldy, *Assistant Professor Physics*

M.S., University of Minnesota; PH.D., *ibid.*

Victor D. Azzi, *Associate Professor of Mechanics*

D.ENG., Yale University

L. Christian Balling, *Assistant Professor of Physics*

M.A., Harvard University, PH.D., *ibid.*

Richard H. Balomenos, *Professor of Mathematics*

M.A., New York University; ED.D., Harvard University

Robert F. Barlow, *Professor of Economics*

M.A., Fletcher School of Law and Diplomacy; PH.D., *ibid.*

James P. Barrett, *Associate Professor of Forest Resources and Genetics*

M.F., Duke University; PH.D., *ibid.*

Gerald M. Batchelder, *Research Associate, Engineering Experiment Station*

M.S.C.E., Purdue University

Edward H. Batho, *Professor of Mathematics*

M.S., University of Wisconsin; PH.D., *ibid.*

- Wayne M. Beasley, *Adjunct Professor of Materials Science Research and Associate Professor, Engineering Experiment Station*
S.M., Massachusetts Institute of Technology
- Homer F. Bechtell, Jr., *Associate Professor of Mathematics*
M.A., University of Wisconsin; PH.D., *ibid.*
- John A. Beckett, *Forbes Professor of Management*
M.B.A., Harvard University; C.P.A., Washington, Illinois, Massachusetts, and New Hampshire
- Charles V. Berney, *Assistant Professor of Chemistry*
PH.D., University of Washington
- Sylvester H. Bingham, *Professor of English*
A.M., Harvard University; PH.D., Yale University
- Fletcher A. Blanchard, *Professor of Electrical Engineering*
M.S., Lehigh University
- Robert L. Blickle, *Professor of Entomology*
M.S., University of New Hampshire; PH.D., Ohio State University
- Melvin T. Bobick, *Associate Professor of Sociology*
A.M., University of Illinois; PH.D., *ibid.*
- Thomas W. Bolland, *Assistant Professor of Business Administration*
M.B.A., University of Chicago; PH.D., *ibid.*
- William E. Bonnice, *Associate Professor of Mathematics*
M.S., University of Washington; PH.D., *ibid.*
- Arthur C. Borror, *Associate Professor of Zoology*
M.S., Ohio State University; PH.D., Florida State University
- Wallace A. Bothner, *Assistant Professor of Geology*
PH.D., University of Wyoming
- James R. Bowring, *Professor of Resource Economics*
M.A., University of Alberta; PH.D., Iowa State University
- Angelo V. Boy, *Associate Professor of Education*
ED.M., Boston University; ED.D., *ibid.*
- C. Hilton Boynton, *Professor of Dairy Science*
M.S., Iowa State College; PH.D., Rutgers University
- Jason E. Boynton, *Assistant Professor of Education*
M.ED., University of New Hampshire
- Allan J. Braff, *Associate Professor of Economics and Business*
M.B.A., Columbia University; PH.D., University of Wisconsin
- Karl H. Bratton, *Professor of Music*
M.A., Columbia University
- Paul E. Bruns, *Professor of Forest Resources*
M.F., Yale University; PH.D., University of Washington
- Wilbur L. Bullock, *Professor of Zoology*
M.S., University of Illinois; PH.D., *ibid.*
- Thomas R. Burns, *Assistant Professor of Sociology*
A.M., Stanford University
- David M. Burton, *Associate Professor of Mathematics*
M.A., University of Rochester; PH.D., *ibid.*
- Gordon L. Byers, *Professor of Soil and Water Science*
M.S., Ontario Agricultural College

- Thomas A. Carnicelli, *Assistant Professor of English***
A.M., Harvard University; PH.D., *ibid.*
- R. Alberto Casas, *Professor of Spanish***
A.M., Columbia University; PH.D., *ibid.*
- John G. Chaltas, *Associate Professor of Education***
M.A., Columbia University; ED.D., *ibid.*
- Donald H. Chapman, *Professor of Geology***
M.A., University of Michigan; PH.D., *ibid.*
- William R. Chesbro, *Professor of Microbiology***
M.S., Illinois Institute of Technology; PH.D., *ibid.*
- Chauncey T. K. Ching, *Assistant Professor of Resource Economics***
M.S., University of California; PH.D., *ibid.*
- David H. Chittenden, *Assistant Professor of Chemical Engineering***
M.S., University of Wisconsin; PH.D., *ibid.*
- Edward L. Chupp, *Professor of Physics***
PH.D., University of California
- Charles E. Clark, *Assistant Professor of History***
M.S., Columbia University; PH.D., Brown University
- David Clark, *Associate Professor of Physics***
M.S., Texas Agricultural and Mechanical College; PH.D., Pennsylvania State College
- Ronald R. Clark, *Associate Professor of Electrical Engineering***
M.E., Yale University; PH.D., Syracuse University
- Jan E. Clee, *Associate Professor of Organizational Development***
M.S., Case Institute of Technology; PH.D., *ibid.*
- Allen R. Cohen, *Assistant Professor of Business Administration***
M.B.A., Harvard University; D.B.A., *ibid.*
- H. Trevor Colbourn, *Professor of History***
M.A., College of William and Mary; PH.D., Johns Hopkins University
- Lawrence P. Cole, *Assistant Professor of Economics***
M.S., Purdue University
- Walter M. Collins, *Professor of Poultry Science and Genetics***
M.S., University of Connecticut; PH.D., Iowa State University
- Nicholas F. Colovos, *Professor of Animal Science***
M.S., University of New Hampshire
- Robert G. Congdon, *Assistant Professor of Psychology***
ED.D., Harvard University
- James G. Conklin, *Professor of Entomology***
M.S., University of New Hampshire; PH.D., Ohio State University
- Carl J. Cooper, *Assistant Professor of Education***
ED.M., Boston University; PH.D., University of Massachusetts
- Arthur H. Copeland, Jr., *Professor of Mathematics***
M.A., University of Michigan; PH.D., Massachusetts Institute of Technology
- Alan C. Corbett, *Associate Professor of Poultry Science***
M.S., University of Maine; D.V.M., Michigan State College
- Robert W. Corell, *Professor of Mechanical Engineering***
M.S., Massachusetts Institute of Technology; PH.D., Case Institute of Technology

- Robert A. Croker, *Assistant Professor of Zoology*
M.S., University of Miami; PH.D., Emory University
- Albert F. Daggett, *Professor of Chemistry*
M.S., University of New Hampshire; PH.D., Columbia University
- G. Harris Daggett, *Professor of English*
M.A., Cornell University; PH.D., University of North Carolina
- J. F. Dawson, *Assistant Professor of Physics*
PH.D., Stanford University
- Mark B. DeVoto, *Assistant Professor of Music*
PH.D., Princeton University
- Richard S. Dewey, *Professor of Sociology*
M.A., Oberlin College; PH.D., University of Wisconsin
- Robert Dishman, *Professor of Political Science*
A.M., University of Missouri; PH.D., Princeton University
- Peter Dodge, *Associate Professor of Sociology*
A.M., Harvard University; PH.D., *ibid.*
- John Dowling, Jr., *Assistant Professor of Physics*
M.S., Arizona State University; PH.D., *ibid.*
- Richard Downs, *Associate Professor of Anthropology*
CERT. OF ETHN., University of Paris; PH.D., University of Leiden
- David D. Draves, *Associate Professor of Education*
M.A., University of Wisconsin; PH.D., *ibid.*
- William H. Drew, *Professor of Resource Economics*
M.S., Rutgers University; PH.D., Vanderbilt University
- William R. Dunlop, *Professor of Poultry Science*
D.V.M., Ontario Veterinary College; V.S., *ibid.*
- Gerald M. Dunn, *Professor of Plant Science and Genetics*
M.S., Purdue University; PH.D., *ibid.*
- Stuart M. Dunn, *Professor of Botany*
M.S., Iowa State University; PH.D., University of Minnesota
- Owen B. Durgin, *Associate Professor of Resource Economics*
M.A., University of New Hampshire
- Edward J. Durnall, *Associate Professor of Education*
M.A., Colorado College; ED.M., Harvard University; ED.D., Oregon State University
- Walter Durost, *Adjunct Professor of Education*
M.A., Columbia University; PH.D., *ibid.*
- Russell Eggert, *Professor of Plant Science*
M.S., Michigan State College
- David W. Ellis, *Associate Professor of Chemistry*
PH.D., Massachusetts Institute of Technology
- Albert Elwell, *Assistant Professor of Education*
M.A., Michigan State University; PH.D., *ibid.*
- Raymond L. Erickson, *Professor of Psychology*
M.A., University of California, Los Angeles; PH.D., *ibid.*
- Robert N. Faiman, *Professor of Electrical Engineering*
M.S.E.E., University of Washington; PH.D., Purdue University
- Stephen S. T. Fan, *Associate Professor of Chemical Engineering*
M.S., Stanford University; PH.D., *ibid.*

- Peter Fernald, *Associate Professor of Psychology***
M.S., Springfield College; PH.D., Purdue University
- John E. Foret, *Assistant Professor of Zoology***
M.S., University of New Hampshire; PH.D., Princeton University
- G. Alfred Forsyth, *Assistant Professor of Psychology***
M.A., North Carolina State University; PH.D., Purdue University
- Bennett B. Foster, *Assistant Professor of Forest Resources***
M.F., Oregon State University; PH.D., Duke University
- Arnold K. Fowler, *Assistant Professor of Animal Science***
M.S., University of Connecticut; PH.D., Ohio State University
- Leslie Fox, *Assistant Professor of Psychology***
PH.D., University of Washington
- Edward N. Francq, *Assistant Professor of Zoology***
M.S., University of Idaho; PH.D., Pennsylvania State University
- George E. Frick, *Adjunct Professor of Resource Economics***
M.S., University of Connecticut
- Albert D. Frost, *Professor of Electrical Engineering***
A.M., Harvard University; SC.D., Massachusetts Institute of Technology
- Thomas E. Furman, *Associate Professor of Botany***
PH.D., Washington State University
- Herman Gadon, *Associate Professor of Business Administration***
PH.D., Massachusetts Institute of Technology
- Henri E. Gaudette, *Assistant Professor of Geology***
M.A., University of Michigan; PH.D., *ibid.*
- Glendon W. Gee, *Assistant Professor of Soil and Water Science***
PH.D., Washington State University
- Henry M. Gehrhardt, *Assistant Professor of Chemical Engineering***
PH.D., Kansas State University
- Glen C. Gerhard, *Assistant Professor of Electrical Engineering***
M.SC., Ohio State University; PH.D., *ibid.*
- Paul A. Gilman, *Associate Professor of Agricultural Education***
M.S., Pennsylvania State University
- Robert C. Gilmore, *Associate Professor of History***
M.A., McGill University; M.A., Yale University; PH.D., *ibid.*
- Filson H. Glanz, *Assistant Professor of Electrical Engineering***
M.S., Stanford University; PH.D., *ibid.*
- Lewis C. Goffe, *Associate Professor of English***
M.A., University of New Hampshire; PH.D., Boston University
- Earl O. Goodman, *Associate Professor of Home Economics***
ED.D., Columbia University
- D. MacDonald Green, *Professor of Biochemistry and Genetics***
PH.D., University of Rochester
- William Greenleaf, *Professor of History***
M.A., Columbia University; PH.D., *ibid.*
- Alan Grishman, *Associate Professor of Music***
M.A., New York University
- Merle D. Guay, *Assistant Professor of Mathematics***
M.A., University of Maine; PH.D., Michigan State University

- Gordon A. Haaland, *Assistant Professor of Psychology***
 PH.D., State University of New York at Buffalo
- Helmut M. Haendler, *Professor of Chemistry***
 PH.D., University of Washington
- Earl C. Hagstrom, *Associate Professor of Psychology***
 SC.M., Brown University; PH.D., *ibid.*
- Francis R. Hall, *Associate Professor of Soil and Water Science***
 M.A., University of California, Los Angeles; PH.D., Stanford University
- Harry H. Hall, *Professor of Physics***
 PH.D., Harvard University
- Otis F. Hall, *Professor of Forest Resources***
 M.F., Yale University; PH.D., University of Minnesota
- Flemming Hansen, *Visiting Associate Professor of Business Administration***
 LIC. MERC., Copenhagen School of Economics and Business Administration
- Robert D. Hapgood, *Associate Professor of English***
 M.A., University of California, Berkeley; PH.D., *ibid.*
- George M. Haslerud, *Professor of Psychology***
 PH.D., University of Minnesota
- David D. Hebert, *Assistant Professor of Education***
 M.ED., Duquesne University; PH.D., Kent State University
- Hans Heilbronner, *Professor of History***
 A.M., University of Michigan; PH.D., *ibid.*
- William F. Henry, *Professor of Resource Economics***
 M.S., University of Connecticut
- Edward J. Herbst, *Professor of Biochemistry***
 M.S., University of Wisconsin; PH.D., *ibid.*
- Guenter Herr, *Assistant Professor of German***
 M.A., University of Freiburg, Germany; PH.D., University of Texas
- Stanley D. Hettinger, *Assistant Professor of Music***
 M.M.E., Vandercook College
- Fred T. Hickson, *Assistant Professor of Microbiology and Genetics***
 M.A., Indiana State University; PH.D., Michigan State University
- John L. Hill, *Associate Professor of Forest Resources***
 M.S., Yale University; D.F., *ibid.*
- Frederick G. Hochgraf, *Associate Professor of Materials Science***
 M.S., Cornell University
- Harold W. Hocker, Jr., *Associate Professor of Forest Resources and Genetics***
 M.F., North Carolina State University; D.F., Duke University
- Albion R. Hodgdon, *Professor of Botany***
 M.S., University of New Hampshire; PH.D., Harvard University
- John A. Hogan, *Carter Professor of Economics***
 A.M., University of Washington; PH.D., Harvard University
- John T. Holden, *Professor of Political Science***
 M.P.A., Harvard University, M.A., *ibid.*; PH.D., *ibid.*, LL.D., Nasson College
- Mary E. Holder, *Associate Professor of Home Economics***
 M.S., Michigan State University
- James B. Holter, *Assistant Professor of Dairy Science***
 M.S., University of Maryland; PH.D., Pennsylvania State University

- Frank K. Hoornbeek, *Associate Professor of Zoology and Genetics*
M.S., Oregon State University; PH.D., *ibid.*
- James O. Horrigan, *Assistant Professor of Business Administration*
M.B.A., University of Chicago; PH.D., *ibid.*
- William Hosek, *Assistant Professor of Economics*
PH.D., University of California, Santa Barbara
- Roger H. Hou, *Assistant Professor of Mathematics*
PH.D., Indiana University
- Robert E. Houston, Jr., *Professor of Physics*
M.S., Michigan State University; PH.D., Pennsylvania State University
- John B. Hraba, *Professor of Electrical Engineering*
M.ENG., Yale University; PH.D., University of Illinois
- Colin D. Hubbard, *Assistant Professor of Chemistry*
PH.D., University of Sheffield
- Edna S. Hudon, *Associate Professor of French*
PH.D., Yale University
- Louis J. Hudon, *Professor of French*
M.A., Yale University; PH.D., *ibid.*
- William B. Hunter, Jr., *Professor of English*
M.A., Vanderbilt University; PH.D., *ibid.*
- Miyoshi Ikawa, *Professor of Biochemistry*
M.S., University of Wisconsin; PH.D., *ibid.*
- Roselmina Indrisano, *Associate Professor of Education*
ED.M., Boston University; ED.D., *ibid.*
- Richard Ingersoll, *Assistant Professor of Sociology*
A.M., State University of Iowa; PH.D., *ibid.*
- Manley R. Irwin, *Associate Professor of Economics*
M.A., University of Michigan; PH.D., Michigan State University
- Robb Jacoby, *Professor of Mathematics*
S.M., University of Chicago; PH.D., *ibid.*
- Erwin A. Jaffe, *Associate Professor of Political Science*
M.A., Rutgers University; PH.D., *ibid.*
- Jesse James, *Associate Professor of Agricultural Education*
M.S., University of Georgia
- Marion E. James, *Associate Professor of History*
M.A., Radcliffe College; PH.D., *ibid.*
- Edmund F. Jansen, *Associate Professor of Resource Economics*
M.S., North Carolina State University; PH.D., *ibid.*
- Charles A. Jellison, *Associate Professor of History*
M.A., Stanford University; PH.D., University of Virginia
- R. Steven Jenks, *Assistant Professor of Business Administration*
M.S., Case Institute of Technology; PH.D., *ibid.*
- Frederick M. Jervis, *Professor of Psychology*
M.A., University of New Hampshire; PH.D., Columbia University
- Richard E. Johnson, *Professor of Mathematics*
M.A., Brown University; PH.D., University of Wisconsin
- Galen E. Jones, *Professor of Microbiology*
M.A., Williams College; PH.D., Rutgers University

- Paul R. Jones, *Professor of Chemistry***
 PH.D., University of Illinois
- William R. Jones, *Associate Professor of History***
 M.A., Harvard University; PH.D., *ibid.*
- Richard L. Kaufmann, *Associate Professor of Physics***
 M.S., Yale University; PH.D., *ibid.*
- Bud B. Khleif, *Associate Professor of Education and Sociology***
 M.A., University of Michigan; PH.D., Johns Hopkins University
- Roland B. Kimball, *Professor of Education***
 ED.M., University of New Hampshire; ED.D., Harvard University
- Mark P. Klein, *Assistant Professor of Physics***
 M.S., Indiana University; PH.D., *ibid.*
- Burton I. Klinger, *Assistant Professor of Psychology***
 M.A., Pennsylvania State University; PH.D., *ibid.*
- Gerald L. Klippenstein, *Assistant Professor of Biochemistry***
 PH.D., Northwestern University
- Louis H. Klotz, *Assistant Professor of Civil Engineering***
 M.C.E., New York University; PH.D., Rutgers University
- John J. Korbel, *Professor of Economics and Business***
 M.B.A., Harvard Business School; PH.D., Harvard University
- Shan S. Kuo, *Professor of Applied Mathematics***
 M.S., Ohio State University; M.E., Harvard University; D.ENG., Yale University
- Dwight Ladd, *Professor of Business Administration***
 M.B.A., Harvard University; D.B.A., *ibid.*
- Robert H. Lambert, *Professor of Physics***
 M.S., Harvard University; PH.D., *ibid.*
- Clarence A. Langer, *Professor of Plant Science***
 M.S., Michigan State University; PH.D., *ibid.*
- Harold E. Langley, Jr., *Associate Professor of Civil Engineering***
 S.M., Massachusetts Institute of Technology; M.S., University of New Hampshire; SC.D., Massachusetts Institute of Technology
- David L. Larson, *Associate Professor of Political Science***
 A.M., Fletcher School, Tufts University; M.A.L.D., *ibid.*; PH.D., *ibid.*
- Marcel E. Lavoie, *Associate Professor of Zoology***
 M.A., University of New Hampshire; PH.D., Syracuse University
- Charles H. Leighton, *Associate Professor of Spanish***
 A.M., Harvard University; PH.D., *ibid.*
- Nelson L. LeRay, Jr., *Adjunct Associate Professor of Resource Economics***
 M.A., Louisiana State University; ED.D., Cornell University
- Arnold S. Linsky, *Assistant Professor of Sociology***
 M.A., University of Washington; PH.D., *ibid.*
- John A. Lockwood, *Professor of Physics***
 M.S., Lafayette College; PH.D., Yale University
- Terence P. Logan, *Assistant Professor of English***
 M.A., University of Wisconsin; PH.D., Harvard University
- David F. Long, *Professor of History***
 A.M., Columbia University; PH.D., *ibid.*

- J. Brent Loy, *Assistant Professor of Plant Science and Genetics***
M.S., Colorado State University; PH.D., *ibid.*
- Gloria G. Lyle, *Associate Professor of Chemistry***
M.S., Emory University; PH.D., University of New Hampshire
- Robert E. Lyle, Jr., *Professor of Chemistry***
M.S., Emory University; PH.D., University of Wisconsin
- Sylvia H. Marple, *Assistant Professor of Home Economics***
M.S., Winthrop College
- Donald Marschner, *Associate Professor of Business Administration***
PH.D., Columbia University
- Grover Marshall, *Assistant Professor of French and Italian***
M.A., Princeton University
- Thomas O. Marshall, *Professor of Education***
ED.M., University of Buffalo; ED.D., Harvard University
- Arthur Mathieson, *Assistant Professor of Botany***
M.A., University of California, Los Angeles; PH.D., University of British Columbia
- Max S. Maynard, *Associate Professor of English***
B.A., University of British Columbia
- John W. McConnell, *Professor of Economics***
PH.D., Yale University
- Lorne A. McFadden, *Associate Professor of Plant Science***
M.S., Cornell University; PH.D., *ibid.*
- Judith Meagher, *Assistant Professor of Education***
ED.M., Boston University; ED.D., *ibid.*
- Donald W. Melvin, *Associate Professor of Electrical Engineering***
M.ENG., Yale University
- Carleton Menge, *Professor of Education***
M.A., University of Chicago; PH.D., *ibid.*
- Theodore G. Metcalf, *Professor of Microbiology***
PH.D., University of Kansas
- Edmund G. Miller, *Associate Professor of English***
M.A., Columbia University; PH.D., *ibid.*
- Eugene S. Mills, *Professor of Psychology***
M.A., Claremont Graduate School; PH.D., *ibid.*
- Richard L. Mills, *Assistant Professor of Business and Economics***
M.A., Indiana University; PH.D., *ibid.*
- Lorus J. Milne, *Professor of Zoology***
M.A., Harvard University; PH.D., *ibid.*
- Herbert C. Moore, *Associate Professor of Dairy Science***
M.S., University of Minnesota
- James D. Morrison, *Assistant Professor of Chemistry***
PH.D., Northwestern University
- William Mosberg, *Associate Professor of Mechanical Engineering***
M.S., Yale University
- Lyman Mower, *Professor of Physics***
PH.D., Massachusetts Institute of Technology
- John Mulhern, *Professor of Physics***
M.A., Boston University; PH.D., *ibid.*

- George Mullen, *Assistant Professor of Physics***
M.S., Syracuse University; PH.D., *ibid.*
- M. Evans Munroe, *Professor of Mathematics***
SC.M., Brown University; PH.D., *ibid.*
- Joseph B. Murdoch, *Professor of Electrical Engineering***
M.S., University of New Hampshire; PH.D., Case Institute of Technology
- Donald M. Murray, *Professor of English***
B.A., University of New Hampshire
- Charlotte Nast, *Professor of Botany***
M.A., University of Wisconsin; PH.D., University of California
- Philip L. Nicoloff, *Associate Professor of English***
M.A., Columbia University; PH.D., *ibid.*
- Eric A. Nordgren, *Assistant Professor of Mathematics***
PH.D., University of Michigan
- Douglas M. Norris, Jr., *Associate Professor of Mechanics***
ED.M., Tufts University; PH.D., Michigan State University
- Philip E. Northway, *Assistant Professor of Education***
A.M.T., Harvard University; M.A.L.S., Simmons College
- Sherrill Nott, *Assistant Professor of Resource Economics***
M.S., Cornell University; PH.D., *ibid.*
- Lawrence W. O'Connell, *Assistant Professor of Political Science***
PH.D., Syracuse University
- David P. Olson, *Associate Professor of Forest Resources***
M.S., University of Maine; PH.D., University of Minnesota
- Amnon Orent, *Assistant Professor of Sociology***
A.M., University of Arizona; PH.D., Boston University
- Wendell Orr, *Assistant Professor of Music***
M.MUS., University of Michigan
- Charles W. Owens, *Assistant Professor of Chemistry***
PH.D., University of Kansas
- Stuart H. Palmer, *Professor of Sociology***
A.M., Yale University; PH.D., *ibid.*
- Lincoln C. Peirce, *Professor of Plant Science and Genetics***
PH.D., University of Minnesota
- Nobel K. Peterson, *Associate Professor of Soil and Water Science***
M.S., Purdue University; PH.D., Rutgers University
- Joseph J. Petroski, *Associate Professor of Education***
ED.M., University of New Hampshire; ED.D., Harvard University
- Frank L. Pilar, *Professor of Chemistry***
M.S., University of Nebraska; PH.D., University of Cincinnati
- Gerald J. Pine, *Associate Professor of Education***
ED.M., Boston College; ED.D., Boston University
- John L. Pokoski, *Assistant Professor of Electrical Engineering***
M.S., Arizona State University; PH.D., Montana State University
- Keith Polk, *Assistant Professor of Music***
M.M., University of Wisconsin; PH.D., University of California, Berkeley
- Solomon Poll, *Professor of Sociology***
A.M., University of Pennsylvania; PH.D., *ibid.*

- Hugh M. Potter, III, *Assistant Professor of English***
M.A., University of North Carolina; PH.D., University of Minnesota
- Robert Puth, *Assistant Professor of Economics***
M.A., Northwestern University; PH.D., *ibid.*
- James Radlow, *Professor of Applied Mathematics***
M.SC., Brown University; PH.D., New York University
- M. Elizabeth Rand, *Associate Professor of Home Economics***
M.ED., Boston University
- R. Marcel Reeves, *Assistant Professor of Entomology and Forest Resources***
M.S., Cornell University; PH.D., State University College of Forestry at Syracuse University
- Hermann W. Reske, *Professor of German***
M.A., University of Toronto; PH.D., *ibid.*
- Avery Rich, *Professor of Botany***
M.S., University of Maine; PH.D., Washington State University
- Mathias C. Richards, *Professor of Botany***
PH.D., Cornell University
- John C. Richardson, *Associate Professor of English***
M.A., Columbia University; PH.D., Boston University
- Joseph T. Riker III, *Assistant Professor of Animal Science***
M.S., Oregon State University; PH.D., Purdue University
- Richard C. Ringrose, *Professor of Poultry Science***
PH.D., Cornell University
- Owen M. Rogers, *Associate Professor of Plant Science and Genetics***
M.S., Cornell University; PH.D., Pennsylvania State University
- George K. Romoser, *Associate Professor of Political Science***
A.M., University of Chicago; PH.D., *ibid.*
- Sam Rosen, *Professor of Economics***
A.M., Harvard University; PH.D., *ibid.*
- Shepley L. Ross, *Professor of Mathematics***
M.A., Boston University; PH.D., *ibid.*
- Kenneth J. Rothwell, *Professor of Economics***
M.A., University of Western Australia; PH.D., Harvard University
- Douglas G. Routley, *Associate Professor of Plant Science***
M.S., Pennsylvania State University; PH.D., *ibid.*
- Edward F. Rutledge, *Assistant Professor of Psychology***
M.A., State University of Iowa; PH.D., *ibid.*
- Darrett B. Rutman, *Professor and Director of Graduate Study in History***
PH.D., University of Virginia
- Frederick Samuels, *Assistant Professor of Sociology***
A.M., University of Hawaii; PH.D., University of Massachusetts
- John J. Sasner, *Assistant Professor of Zoology***
M.S., University of New Hampshire; PH.D., University of California
- Godfrey Savage, *Associate Professor of Mechanical Engineering***
M.S., Stanford University; M.B.A., Harvard University; ENGR., Stanford University
- Peter R. Savage, *Associate Professor of Political Science***
M.A., Yale University; PH.D., Cornell University

- Albert K. Sawyer, *Associate Professor of Chemistry***
M.S., University of Maine
- Philip J. Sawyer, *Associate Professor of Zoology***
M.S., University of New Hampshire; PH.D., University of Michigan
- Edward P. Sayre, *Assistant Professor of Electrical Engineering***
M.E.E., New York University
- Paul E. Schaefer, *Associate Professor of Zoology***
M.S., Ohio State University; PH.D., *ibid.*
- Cecil J. Schueer, *Professor of Geology***
M.A., Harvard University; PH.D., Cornell University
- Richard W. Schreiber, *Professor of Botany and Genetics***
M.S., University of New Hampshire; PH.D., University of Wisconsin
- Ernst J. Schreiner, *Adjunct Professor of Forestry and Genetics***
PH.D., Columbia University
- Charles B. Schriver, *Assistant Professor of Chemical Engineering***
M.S., Iowa State University; PH.D., *ibid.*
- James H. Schulz, *Assistant Professor of Economics***
PH.D., Yale University
- Marc L. Schwarz, *Assistant Professor of History***
A.M.T., Harvard University; PH.D., University of California, Los Angeles
- Alex Shigo, *Adjunct Associate Professor of Botany***
M.S., West Virginia University; PH.D., *ibid.*
- Ronald E. Shor, *Assistant Professor of Psychology***
M.A., Kansas University; PH.D., Brandeis University
- Samuel D. Shore, *Assistant Professor of Mathematics***
M.A., Pennsylvania State University; PH.D., *ibid.*
- Robert J. Silverman, *Professor of Mathematics***
M.S., University of Chicago; PH.D., University of Illinois
- Robert E. Simpson, *Assistant Professor of Physics***
A.M., Harvard University; PH.D., *ibid.*
- Winthrop C. Skoglund, *Professor of Poultry Science***
M.S., Pennsylvania State College; PH.D., Pennsylvania State University
- H. Richard Skutt, *Associate Professor of Electrical Engineering***
M.S.E.E., Virginia Polytechnic Institute; PH.D., Worcester Polytechnic Institute
- Lawrence W. Slanetz, *Professor of Microbiology***
PH.D., Yale University
- Roger P. Sloan, *Assistant Professor of Forest Resources***
M.P.A., Harvard University
- Gerald L. Smith, *Associate Professor of Animal Science***
M.S., Pennsylvania State University; PH.D., *ibid.*
- M. Daniel Smith, *Associate Professor of Education***
M.M., University of Michigan; ED.M., Harvard University; ED.D., *ibid.*
- Philip M. Smith, *Assistant Professor of Education***
ED.M., Boston University
- Samuel C. Smith, *Associate Professor of Biochemistry and Poultry Science***
M.S., Pennsylvania State University; PH.D., *ibid.*
- James L. Spangenberg, *Associate Professor of Home Economics***
M.A., University of Michigan; PH.D., Pennsylvania State University

- Donald Steele, *Professor of Music***
M.A., Colorado College
- Glenn W. Stewart, *Associate Professor of Geology***
M.S., Syracuse University; M.A., Harvard University
- James A. Stewart, *Assistant Professor of Biochemistry***
PH.D., University of Connecticut
- Samuel E. Stokes, *Associate Professor of French***
M.A., Columbia University; PH.D., *ibid.*
- Deborah E. Stone, *Assistant Professor of Education***
ED.M., Boston University
- Kerwin C. Stotz, *Associate Professor of Electrical Engineering***
M.E.E., Rensselaer Polytechnic Institute; PH.D., *ibid.*
- Murray Straus, *Professor of Sociology***
A.M., University of Wisconsin; PH.D., *ibid.*
- Richard G. Strout, *Associate Professor of Poultry Science***
M.S., University of New Hampshire; PH.D., *ibid.*
- Margaret S. Sullivan, *Assistant Professor of French***
B.A., Fresno State College
- Emery F. Swan, *Professor of Zoology***
PH.D., University of California, Berkeley
- Charles K. Taft, *Professor of Mechanical Engineering***
M.S., Case Institute of Technology; PH.D., *ibid.*
- Arthur E. Teeri, *Professor of Biochemistry***
M.S., University of New Hampshire; PH.D., Rutgers University
- John Terninko, *Assistant Professor of Business Administration***
M.S., Massachusetts Institute of Technology; PH.D., Case Institute of Technology
- Edward K. Tillinghast, *Assistant Professor of Zoology***
M.S., University of Rhode Island; PH.D., Duke University
- Herbert Tischler, *Professor of Geology***
M.A., University of California, Berkeley; PH.D., University of Michigan
- J. John Uebel, *Associate Professor of Chemistry***
PH.D., University of Illinois
- Dale S. Underwood, *Professor of English***
M.A., Yale University; PH.D., *ibid.*
- Willard E. Urban, Jr., *Associate Professor of Biometrics and Genetics, Agricultural Experiment Station***
M.S., Iowa State University; PH.D., *ibid.*
- Russell Valentine, *Associate Professor of Mechanical Engineering***
M.S., Purdue University
- Oliver P. Wallace, Sr., *Associate Professor of Forest Resources***
M.F., University of Michigan; PH.D., *ibid.*
- Tung-Ming Wang, *Associate Professor of Civil Engineering***
M.S.C.E., University of Missouri; PH.D., Northwestern University
- Peter Waring, *Associate Professor of Music***
M.A., Harvard College; SAC. MUSIC DOC., Union Theological Seminary School of Sacred Music
- Robert I. Watson, *Professor of Psychology***
A.M., Columbia University; PH.D., *ibid.*

- Dwight Webb, *Assistant Professor of Education***
M.A., University of Redlands; PH.D., Stanford University
- Laurance Webber, *Director, Engineering Experiment Station***
M.E., University of New Hampshire; M.S., *ibid.*
- William R. Webber, *Professor of Physics***
M.S., University of Iowa; PH.D., *ibid.*
- James Harold Weber, *Associate Professor of Chemistry***
PH.D., Ohio State University
- Otho S. Wells, *Assistant Professor of Plant Science***
M.S., Michigan State University; PH.D., Rutgers University
- William Wetzal, Jr., *Assistant Professor of Business Administration***
M.B.A., Temple University
- Richard R. Weyrick, *Assistant Professor of Forest Resources***
M.F., University of Minnesota; PH.D., *ibid.*
- Charles M. Wheeler, Jr., *Associate Professor of Chemistry***
M.S., West Virginia University; PH.D., *ibid.*
- Douglas L. Wheeler, *Assistant Professor of History***
A.M., Boston University; PH.D., *ibid.*
- Christopher C. White, *Assistant Professor of Mathematics***
M.A., University of Oregon; PH.D., *ibid.*
- John B. Whitlock, *Associate Professor of Music***
M.A., State University of Iowa; PH.D., *ibid.*
- John D. Wicks, *Associate Professor of Music***
A.M., Harvard University; PH.D., *ibid.*
- Thomas A. Williams, Jr., *Professor of English***
M.A., University of New Hampshire
- Robin D. Willits, *Associate Professor of Business Administration***
PH.D., Massachusetts Institute of Technology
- Alden L. Winn, *Professor of Electrical Engineering***
S.M., Massachusetts Institute of Technology
- William G. Withoft, *Assistant Professor of Mathematics***
M.S., DePaul University; S.M., University of Chicago; PH.D., Illinois Institute of Technology
- Harold F. Wochholz, *Assistant Professor of Electrical Engineering***
M.S.E.E., Michigan State University
- John Woodruff, *Associate Professor of Political Science***
M.A., Fletcher School of Law and Diplomacy; PH.D., Boston University
- Paul A. Wright, *Professor of Zoology***
A.M., Harvard University; PH.D., *ibid.*
- Dwayne Wrightsman, *Associate Professor of Finance***
M.B.A., Indiana University; PH.D., Michigan State University
- Frederic W. Wurzburg, *Associate Professor of Political Science***
PH.D., Columbia University
- Marjory Wybourn, *Professor of Home Economics***
M.A., Columbia University; ED.D., *ibid.*
- W. Tseng Yang, *Assistant Professor of Mechanical Engineering***
M.S., Michigan College of Mining and Technology; D.ENG., Yale University

- Yin-Chao Yen, *Adjunct Professor of Chemical Engineering***
M.S., Kansas State University; PH.D., Northwestern University
- Asim Yildiz, *Professor of Mechanics***
M.S., Technical University of Istanbul; D.ENG., Yale University
- John A. Yount, *Associate Professor of English***
M.F.A., State University of Iowa
- O. T. Zimmerman, *Professor of Chemical Engineering***
M.S.E., University of Michigan; PH.D., *ibid.*
- J. Harold Zoller, *Professor of Civil Engineering***
PH.D., University of Wisconsin

Index

- Administrative officers 8
- Admission 19
- Agricultural Education 29
- Agricultural Experiment Station 13
- Alumni Association 17
- Alumni fellowships 23
- Animal Nutrition Laboratory 13
- Animal Sciences 31
- Assistantships 22

- Background 11
- Biochemistry 23
- Biology 35
- Botany 36
- Bureau of Educational Research 13
- Business Administration 39

- Calendar 5
- Chemical Engineering 44
- Chemistry 46
- Civil Engineering 52
- Committees 10
- Computation Center 13
- Cooperative Extension Service 13
- Course Numbering System 27
- Counseling and Testing Center 15
- Credits 20

- Dining 16
- Dissertation fellowships 23

- Economics 56
- Education 59
- Electrical Engineering 66
- Engineering Design and Analysis Laboratory 13
- Engineering Experiment Station 13
- English 70
- Entomology 75
- Expenses 15, 16, 21

- Facilities 12
- Faculty 151
- Fellowships 22
- Forest Resources 76
- French and Italian 79

- Genetics 81
- Geology 85
- German and Russian 87
- Grades 21
- Graduate assistantships 22
- Graduate programs 24

- Health services 15
- History 91
- Home Economics 97
- Housing 16

- IBM Key Codes 28
- Interdisciplinary Options and Programs 99

- Jackson Estuarine Laboratory 14

- Library 12

- Map 4
- Martin Luther King Scholarship 23
- Mathematics 100
- Mechanical Engineering 106
- Memorial Union 15
- Microbiology 111
- Music 113

- NDEA fellowships 23
- New England Center 13

- Paul Arts Center 12
- Physical Education facilities 12
- Physics 119
- Placement Service 16
- Plant Science 122
- Political Science 124
- Project assistantships 22
- Psychology 129
- Public Administration 13, 125

- Regulations 19
- Requirements, Doctor's 26
- Requirements, Master's 25
- Resource Economics 134
- Resources Development Center 13

Scholarships 22
Services 15
Sociology 136
Social Science Center 12
Soil and Water Science 142
Space Science Center 13
Spanish and Classics 144
Student activities 12
Summer fellowships 23

Technology 146
Television station 13
Theatre 14

Thesis 25
TOEFL 20
Traineeships 23
Trustees 7
Tuition 21
Tuition scholarships 22

University Extension Service 13
UNH fellowships 23

Water Resources Research
Center 13

Zoology 146

Call
378.742
N5345
1969/70

